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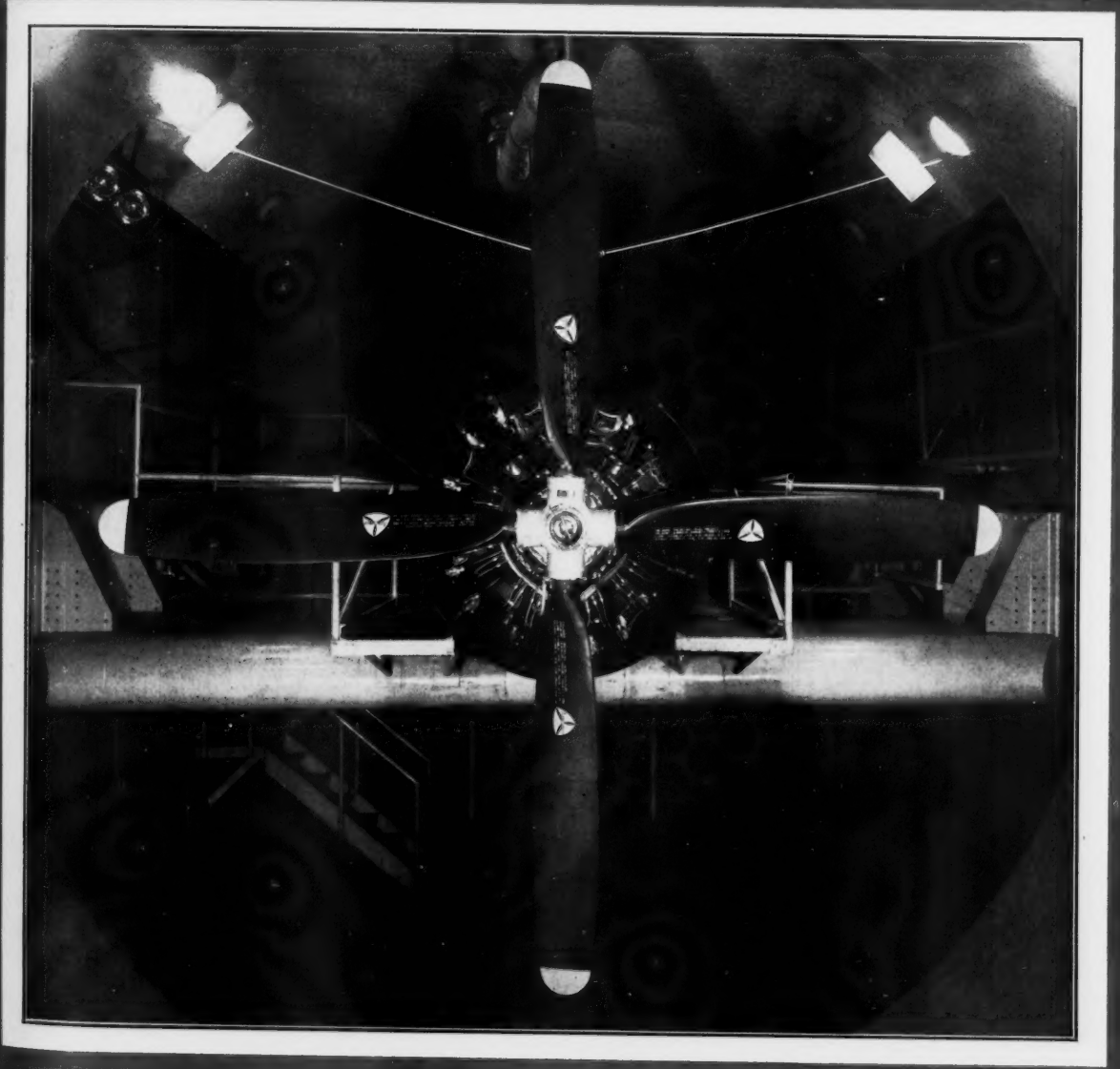

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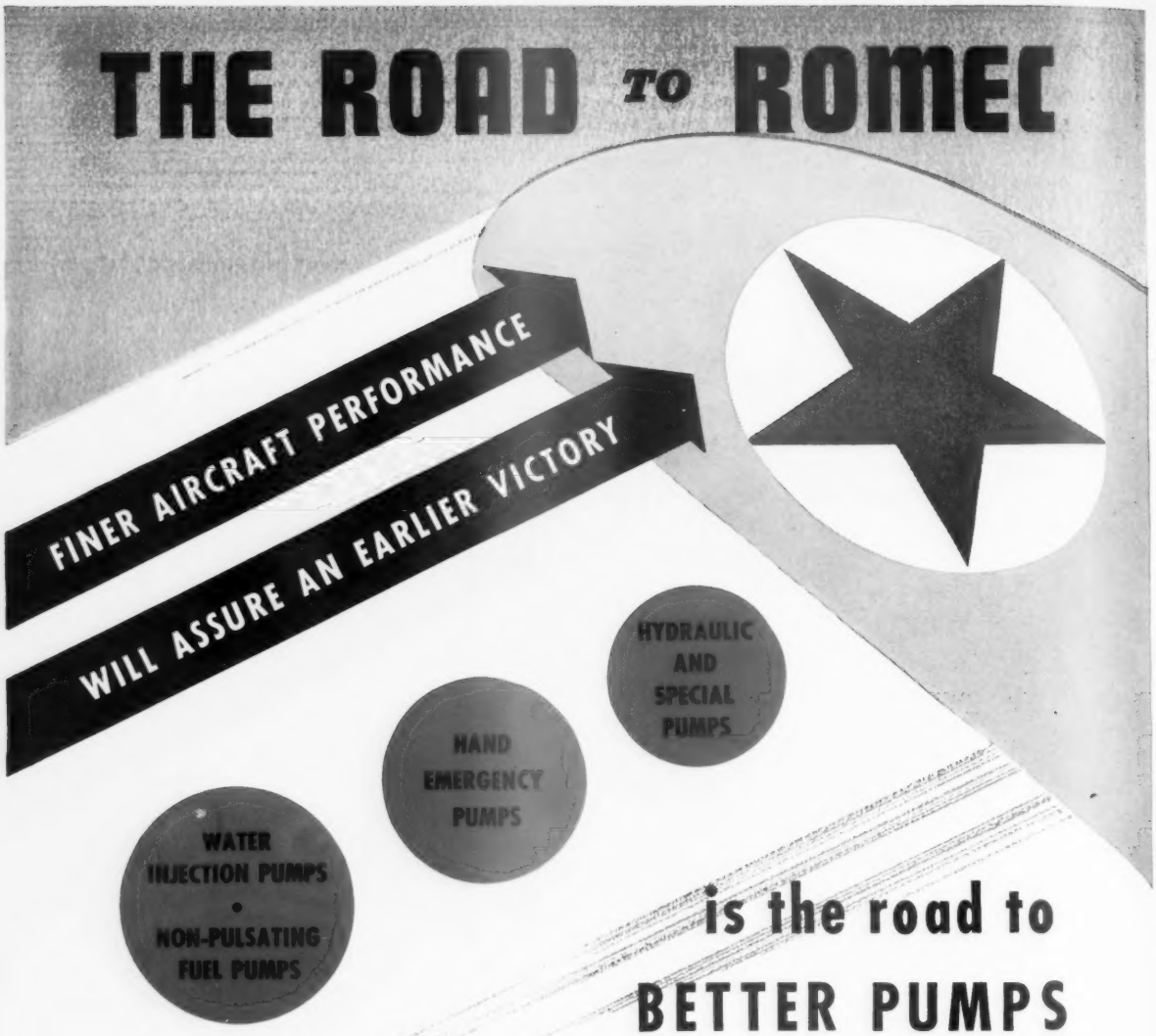

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Aeronautical Engineering Review: United States and possessions, 1 year, $3.00; single copies, $0.30. Foreign countries including Canada (American Currency Rates), 1 year, $3.50; single copies, $0.35.

Journal of the Aeronautical Sciences: Published Quarterly in January, April, July, and October. United States and possessions, 1 year, $7.00; single copies, $2.00. Foreign countries including Canada (American Currency Rates), 1 year, $9.00; single copies, $2.50.

Entered as second-class matter at the Post Office, Easton, Pa., April 29, 1942. Acceptance for mailing at a Special Rate of Postage as provided for in the Act of August 24, 1912.

Publication Office: 20th & Northampton Streets, Easton, Pa.

Editorial Office: 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N. Y.

Notices of change of address should be sent to the Institute at least 30 days prior to actual change of address.

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An Aeroprop propeller ready for test run. Photograph courtesy Aeroproducts Division of General Motors Corporation.

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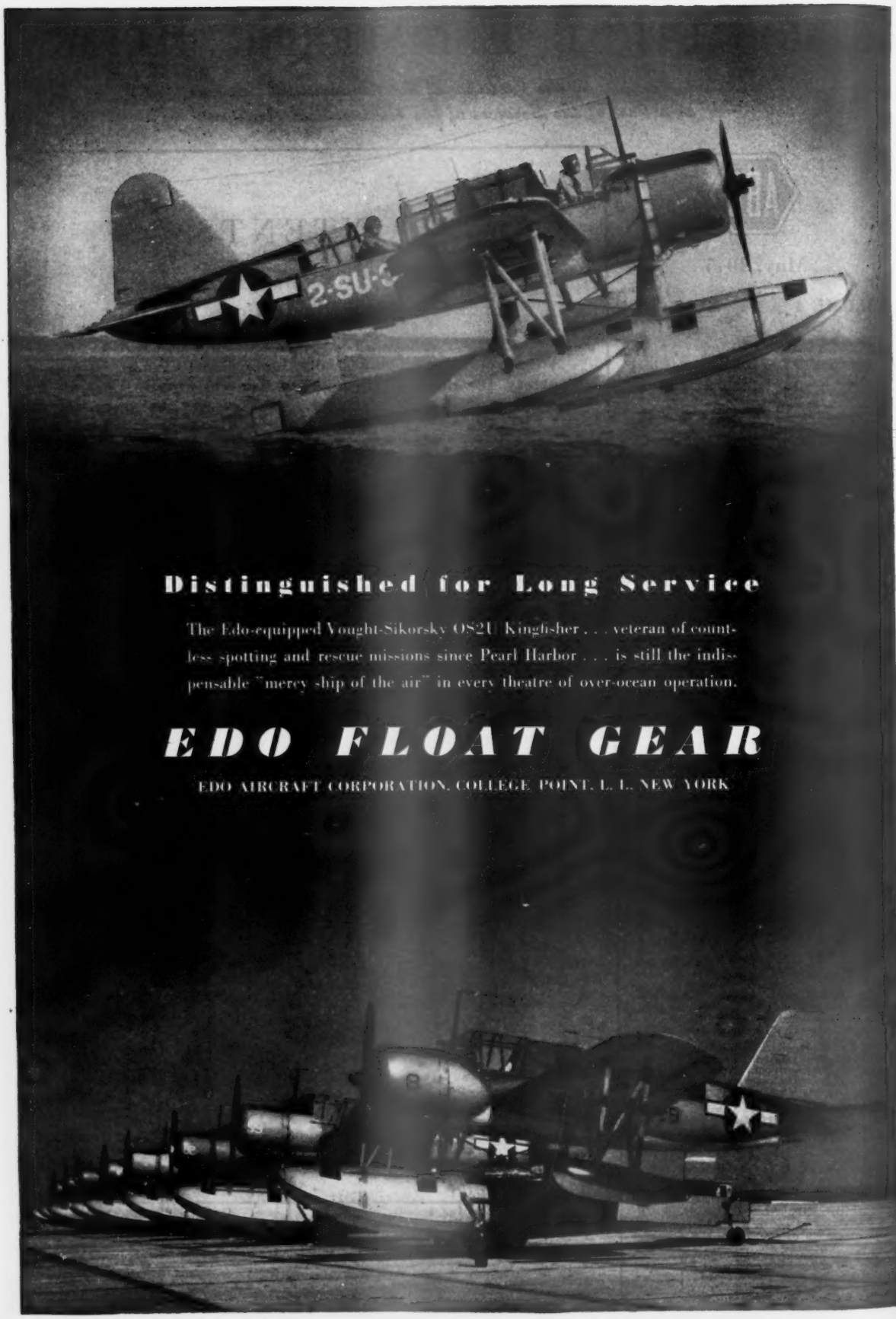
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Electrical Flight Control

L. M. APPLEGATE* AND V. H. QUAYLE†
Wright Field

Major L. M. Applegate.

Lt. V. H. Quayle.

Introduction

Electrical flight control in aircraft, as dealt with in this paper, relates to the operation of airplane control surfaces by power actuators, either electric or hydraulic, which are controlled through electric circuits. The need for these complications in aircraft has developed as the result of the increase in air pressures and forces encountered in the operation of control surfaces, especially on large airplanes. There are several large planes, either in actual use or under construction, in which control surfaces are operated by boosters or actuators providing forces in excess of the forces that can conveniently be provided by the pilot. There is at least one fighter plane in which part of the control surfaces is power actuated.

In some of these airplanes, the forces required to operate the control surfaces are not so large that they could not be supplied by man power if sufficient sacrifice in maneuverability were permissible. It might be said that power operation of the control surfaces up to this time has been for ease of operation and maneuverability, rather than being absolutely necessary to take care of large forces. In the present power boost installations, the ratio of force exerted by the booster to the force on the pilot's control column varies from about 3 to 1 to about 10 to 1. One, and possibly more, aircraft uses a flying tab system of control, in which the force provided by the tab is of the order of ten times the force provided by the pilot. The ratios of actuator force to pilot force could greatly exceed those now required if some of the unconventional types of aircraft now under consideration should be built. In one airplane that probably will be built, the control surfaces will require forces, expressed as torques, which will approach 10,000 lb. ft. A purpose of this paper is to present some of the aspects of the control problem as it might apply to aircraft of such unusual size and type.

The Control System

The control system of the airplane comprises the control surfaces, the mechanisms that move the surfaces, the control transmission from the pilot, the pilot's motive action, and the pilot's senses. In autopilot systems the pilot's senses are represented by gyroscopes and associated mechanisms. In present aircraft control systems, the pilot senses the condition requiring the action and is conscious of the physical effort required to produce the action. He is aware of accelerations of the aircraft resulting from the action of the control surfaces. This sensing of all the phases of control action, together with the physical effort required to control the airplane, develops a coordination of thought, reflex, and action in the pilot which is complete. The phrase, "flying by the seat of the pants," is a way of expressing the conception of the pilot's coordination.

With the increase in size, wing loading, and speed of aircraft and the consequent restrictions on maneuverability, the pilot's coordination is being supplemented more and more by mechanical contrivances and control instruments. In cruising and in bombing runs, flight in large planes is now normally controlled by the autopilot. In formation flying, manual controls superimposed on the autopilot controls have been developed to relieve the pilot of the physical exertion of controlling the airplane. They also permit the pilot to make adjustments in the plane's course at will while letting the autopilot control the plane except when adjustment is needed. For this kind of flight the "seat of the pants" coordination lacks the element of physical exertion and to that extent is incomplete.

Control "Feel"

This kind of flight control, up to the present time, has been restricted in service not entirely, but largely, to level flight. In the large airplanes with high-torque controls now being planned, flight without the benefit of the feeling of physical exertion may have to be accomplished for all conditions. The loss of the "feel" of the force on the control surfaces is considered objectionable by some, and probably most, pilots and designers. Accordingly, in the current designs, feel is provided in the controls either by a ratio of control column force to actuator force or by a "synthetic" force that is roughly proportional to control column displacement. The value of these "feels" is questionable, especially that of the "synthetic" feel. Synthetic feel that is not proportional to the actual forces on the control surfaces may give the pilot a false impression even though he realizes that the forces he feels are not truly representative of the forces on the airplane.

The proportional feel is safer than the synthetic, but the mental evaluation of large forces on the control surfaces by feeling small proportional forces is likely to be of little value. For example, in an airplane where the force on the control surface varies from zero to 10,000 lb. ft., the forces on the control column may vary from 0 to 100 lb. ft. or perhaps from 0 to 10 lb. ft. In one case, the pilot, if he is going to evaluate mentally the actual control forces, must in effect multiply his feel impressions by 100 in one case and in the other by 1,000. In these instances it is probable that the pilot would use the angular displacement of the control column as much as the force exerted to form his impression of control surface force.

A safer development may be that of leaving out synthetic feel entirely and making the control column forces as small as possible. If the pilot flies without physical exertion, he will coordinate the displacement of the control column and rudder pedals with the feeling of acceleration produced by maneuver. This may have advantages even in aircraft where the forces required to operate the control surfaces can be provided directly by the pilot but which would require such effort as to prevent his being fully cognizant of the accelerations of the plane. The benefits of attention to accelerations may be greater

Presented at the National Fall Meeting, I.A.S., Dayton, Ohio, November 9–10, 1944.

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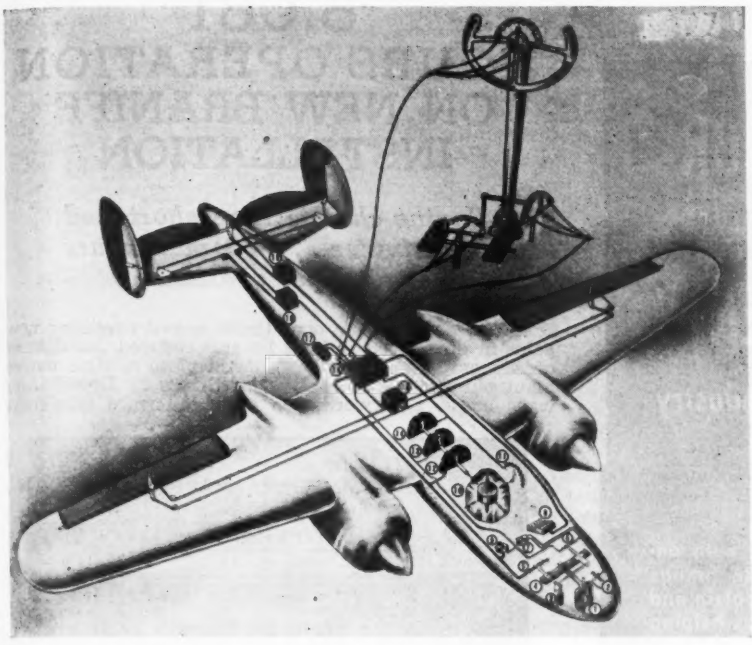

Fig. 1. Diagrammatic layout of electrical flight-control system.

than the loss of coordination resulting from the lack of control force sensing, especially in large aircraft where the forces on the control surfaces do not convey to the pilot any accurate impression of structural loading on the plane. In these instances, the feel of acceleration should be a more useful component of coordination than any other "feel" that could be used.

Leaving artificial elements of coordination out of the system, the problem becomes one of straightforward engineering. The engineering problem can be divided into three parts: the autopilot and pilot's control mechanisms, the control surface actuators, and the communication system between the sensing mechanisms and the actuators. This paper is concerned primarily with the actuating and communicating parts of the system.

Autopilot Systems

There are autopilot systems already in existence that contain the basic elements for complete aircraft control. The principles of the existing servomotors in both American and foreign aircraft can be applied to airplanes in which the forces required are much larger than in any existing equipment. The existing, although partly experimental, remote control devices can be redesigned, with some additions, to fulfill the requirements of the pilot's control column and rudder pedals. The principles of existing data transmission and amplification systems are applicable to systems of higher power rating. A hypothetic setup for airplane control is shown in Fig. 1. Here, control circuits originating at the control column and rudder pedals are superimposed on an existing type of autopilot. This represents a complete system in which the pilot controls the plane through the same servomotors that are used with the autopilot. At will, the pilot can take over from the autopilot for maneuver by disconnecting the autopilot, or the pilot can leave the controls interconnected during level flight and make occasional adjustments in the plane's course with the autopilot in normal operation.

Pilot's Controls

There are various ways in which the pilot's controls can communicate with the servomotors in a system, but the only methods that can be expected to receive serious consideration are those that can tie in with autopilot controls. This condition directs attention to potentiometers and to self-synchronous arrangements. Fig. 2 shows a control system using potentiometers. This system is one used for controlling a waste gate in a turbosupercharger installation, but the principles are applicable to many other types of controls. In this system, relative angular displacement between a sending and a receiving potentiometer produces a potential difference that is amplified and used to actuate a motor in one direction or the other. For example, in Fig. 2, if the pressure selector potentiometer is changed, the waste gate motor runs until the balancing potentiometer is positioned to restore a zero potential difference at the input of the amplifier.

Potentiometer Control

The potentiometer control system has an advantage of flexibility, illustrated in Fig. 2, in that a number of potentiometers can be readily used in the same control circuit. This permits the algebraic addition of several independently variable potential differences. In Fig. 2, there are five control elements introduced: calibration, pressure selection, pressure control, acceleration, and overspeed. These five potential differences are added and impressed on the input grid of the amplifier. The amplifier delivers a current determined by the magnitude and polarity or phase of

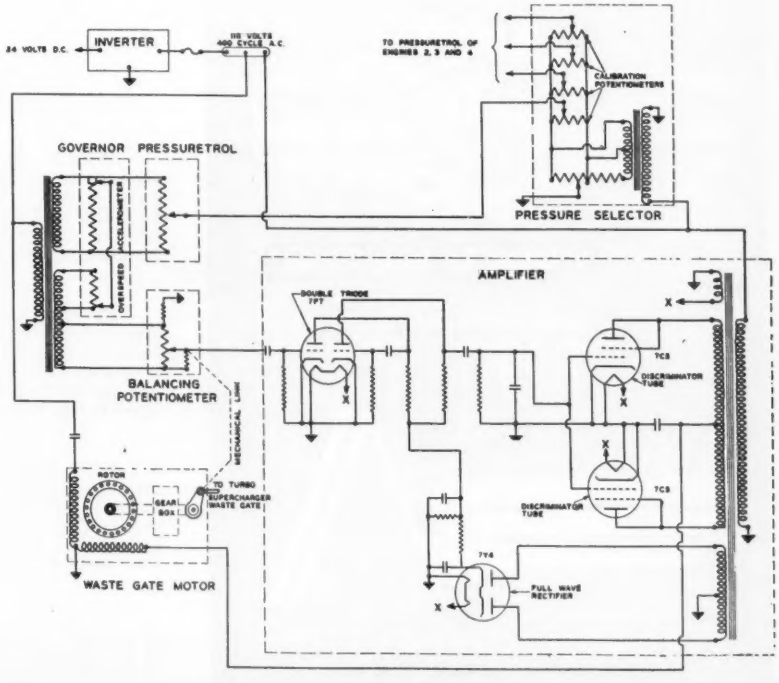

Fig. 2. Schematic circuit of electronic control system.

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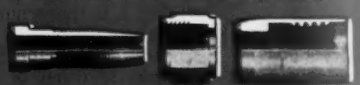

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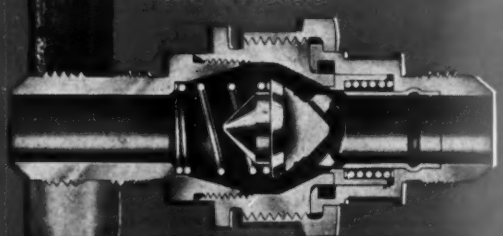

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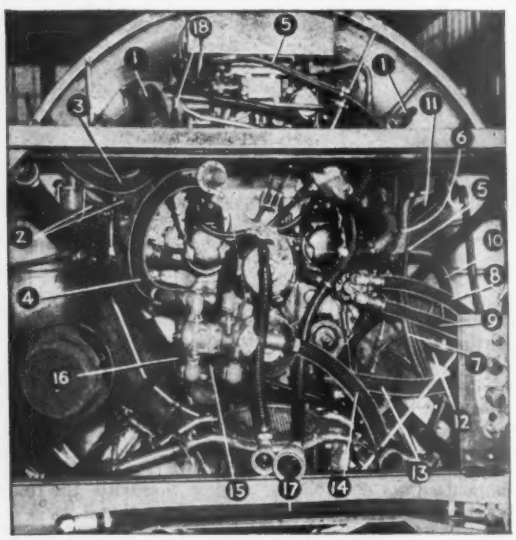

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10. *Fuel Cross Feed*
11. *Fuel Line*
12. *Fuel Suction*
13. *Vac. Suction*
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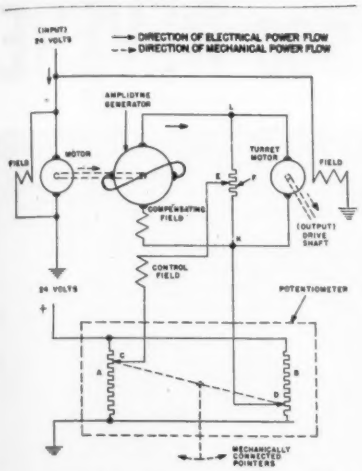

Fig. 3. Schematic diagram of amplidyne control circuit.

the input signal. The motor is a two-phase induction motor, one phase winding of which is continuously excited. The other phase winding is excited by the amplifier either 90 or 270 electrical degrees out of phase with the first winding.

The potentiometers in this system carry only small currents needed for amplifier control. The dimensions are small and the mechanical adaptability is favorable to many types of installation. When the potentiometers are carefully wound, they are accurate and reliable. Thousands are in service subjected to wide variations of climatic conditions, vibration, and maintenance, and they are giving comparatively little trouble. The amplifier shown in Fig. 2 is one that has served effectively in some thousands of units, but better amplifiers are expected to come out of research now being conducted. Amplifiers for larger outputs have been designed using tubes operating Class B and for still larger outputs using thyrations. An experimental thyration amplifier has been built in the same space which is capable of twice the output of the one shown in Fig. 2. In some other amplification and control systems, saturable core reactors or transformers are used to permit the control of relatively large power with no more than one or two watts in the vacuum tube output.

Self-Synchronous Control

The self-synchronous type of data transmission differs from the potentiometer system in that it has no moving contacts except slip rings. It is rugged and accurate, and it is adaptable to some types of data transmission that other systems will not work in. In particular, where continuous rotation is required, the self-synchronous system is especially to be desired. Where self-synchronous data transmission is used in aircraft, those types using amplifiers responsive to phase difference between the sending and receiving machine are preferred to those using mechanical methods of follow-up. In general, either self-synchronous or potentiometer systems of data transmission can be used for any electrical flight-control system contemplated up to this time. Each system has advantages, but the trend ultimately may be expected to be toward the self-synchronous system, partly because of its freedom from sliding contacts.

Actuating Mechanisms

Hydraulic Systems

In the application of actuating mechanisms to control surfaces, hydraulic systems have been preferred up to this time. This is to be expected in view of the flexibility and high degree of development of hydraulic apparatus. Hydraulic systems are especially adaptable to those mechanisms where the movement is a simple angular displacement which can be accomplished by a piston and cylinder. The high pressures used in some systems promote compactness. But there are disadvantages in hydraulic systems that leave openings for consideration of other systems. Some hydraulic fluid is inflammable. Long hydraulic lines are heavy. Leaks are a nuisance and a hazard.

Electromechanical Systems

If an electromechanical system is to compete in all respects with hydraulic systems, it should be capable of accurate and smooth control at variable speed. It should also provide a high-output torque under control of a small exciting current. An electromechanical system fulfilling these requirements is the Amplidyne. The Amplidyne comprises a motor served by the main generators of the airplane, a special amplidyne generator driven by the motor, and a final drive motor served by the amplidyne generator. The amplidyne generator is controlled by a relatively small current provided by a thermionic amplifier. A schematic diagram of an amplidyne turret actuating system is shown in Fig. 3. In this system the turret operation is as smooth and as forceful as in hydraulic systems. The weight and efficiency are comparable with hydraulic systems. Both weights and efficiencies of equipment of these kinds depend so much on the particular installation and duty cycle that conclusive statements of comparison based on generalities could be misleading.

Remote Control

In airplane remote control of the control surfaces, electric circuits from the control column to the actuating mechanisms are preferable to hydraulic lines because they weigh less, are easier to install, and are less hazardous in combat. The actuating mechanisms can be either electrical or hydraulic, provided they are designed to respond smoothly and accurately to the movement of the pilot's controls. This can be accomplished by methods already developed in which a pilot valve or other control device is actuated by a self-synchronous or equivalent device. Figs. 4, 5, and 6 show hydraulic and mechanical systems that can be remotely controlled by electric circuits by methods already developed.

Fig. 4 shows a hydraulic control system in which the actuator is a cylinder and piston. The piston is controlled by a balanced valve that can be operated by

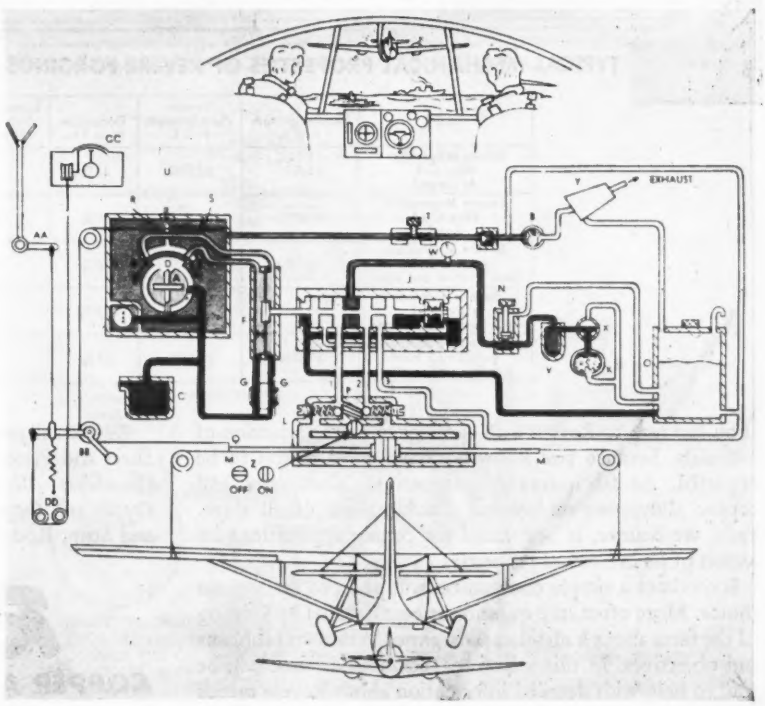

Fig. 4. Hydraulic control system with cylinder actuator.

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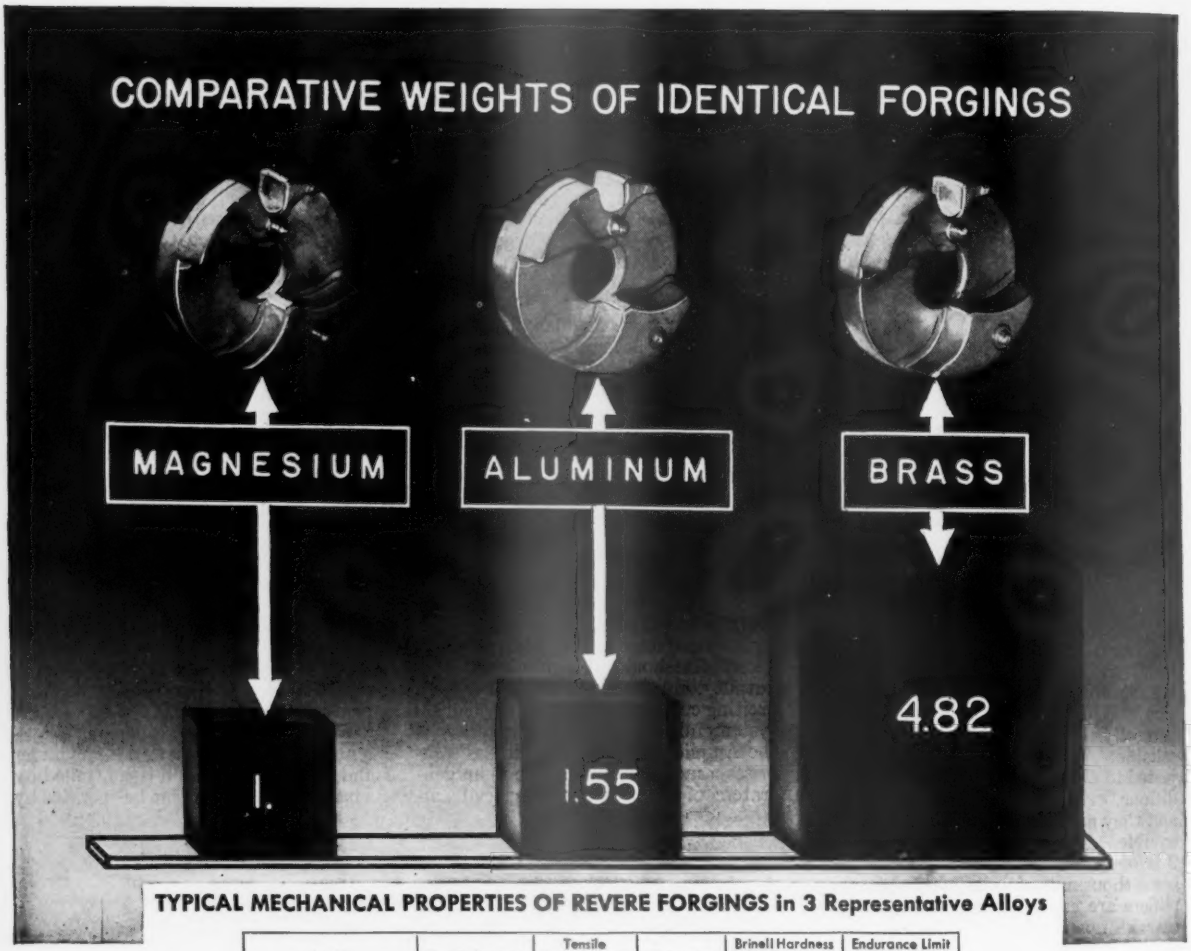

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Revere Magnesium Alloy O-1A Aged	40,000	34,000	6%	72	16,000
Revere Magnesium Alloy O-1HTA Heat Treated and Aged	50,000	34,000	6%	72	16,000
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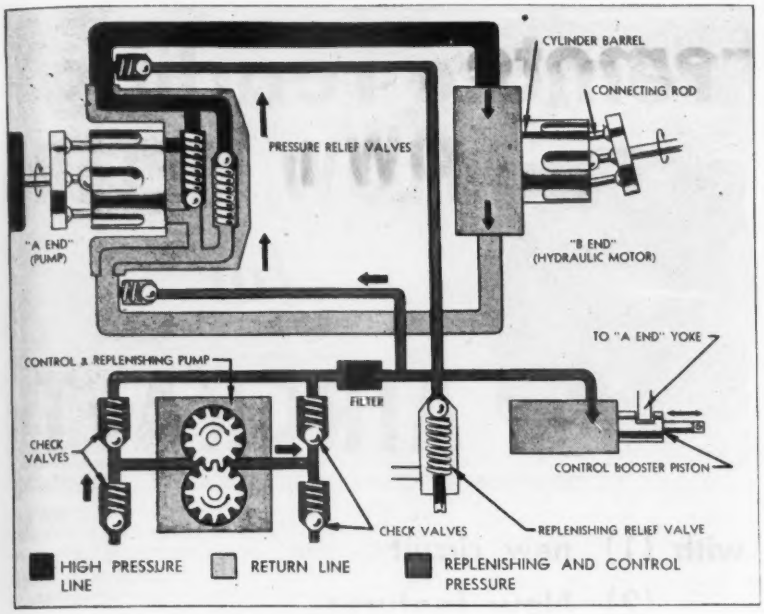

Fig. 5. Hydraulic control system with rotary actuator.

any control arrangement that might be desired. The system as shown in Fig. 4 uses a continuously running pump maintaining constant pressure against a relief valve. This method of operation is so inefficient that it could not be economically used for other than installations requiring low power. The system has the advantage of permitting the use of pressures as high as 3,000 lbs. per sq.in. with consequent economy in the weight and dimensions of actuating parts. At 3,000 lbs. per sq.in., a 3-in. piston will produce more than enough force to operate the heaviest control surface load yet considered. The advantages of this simple system can be combined with those of higher efficiency by using a pressure unloading valve and a high-pressure accumulator instead of the high-pressure discharge through the relief valve. In this arrangement the pump runs continuously, but, when the load on the actuator is relieved, the unloading valve permits the pump to circulate fluid freely through a reservoir at nearly zero pressure. The load on the pump shifts intermittently between no-load and full-load.

Another hydraulic system that is more efficient than that in Fig. 4 is shown in Fig. 5. In this system, the pump operates at variable stroke, depending on the speed at which it is desired to drive the hydraulic motor. The motor is built substantially like the pump, except that the length of stroke is constant. In the pump, the length of stroke can vary from maximum to zero. With zero stroke, the no-load losses of the system are comparatively small. The piston motor operates at a speed proportional to the stroke length in the pump. A replenishing pump, shown in Fig. 5, is provided to keep the variable stroke pump and piston motor circuit filled and under pressure. Hydraulic actuators of this kind are used in air and naval craft for operating turrets and guns. They are used also for antiaircraft gun carriage operation and for machine tool drives. They are adaptable to drives requiring high torques at variable speed, and they would usually be considered where the amount or continuity of travel or rotation cannot be provided by the type of actuator shown in Fig. 4.

Mechanical Counterparts of Hydraulic System

Mechanical counterparts of the variable-stroke hydraulic system have been tried experimentally, some of them using multiple mechanical impulses of varying length. They have one advantage over the hydraulic systems in that no large quantity of oil is involved. The efficiencies of the best of the variable speed mechanical drives are said to be of the order of 60 per cent; of others, possibly half of that. These drives, except the most simple ones, appear to be a rather forced sort of mechanical creation, and there is not very much to encourage confidence in them in competition with other systems.

Power Transmission

In hydraulic systems the pumps can be located at the propulsion engines, in which case long hydraulic lines will run to the actuators or the pumps can be at the actuators, in which case the pumps are driven by individual motors. If the latter arrangement is used, the possibility of driving the control surface through mechanical reduction gearing comes in for comparison with the hydraulic actuator. An electromechanical power transmission system is shown in Fig. 6. This system is used in the autopilot arrangement illustrated in Fig. 1. Friction clutches actuated by solenoids are used so the motor can run continuously in one direction. This has the advantage of avoiding repetitive motor starting transients on the system supplying power to the servomotors. This system can be designed for large torques. It is susceptible to endless variation in mechanical details and is comparatively simple to manufacture. It is relatively efficient and its weight per horsepower is reasonable.

If, in Fig. 6, the motor is made reversible, the clutches and half the gearing can be eliminated. This increases efficiency and reduces weight, but the motor starting transients may be ob-

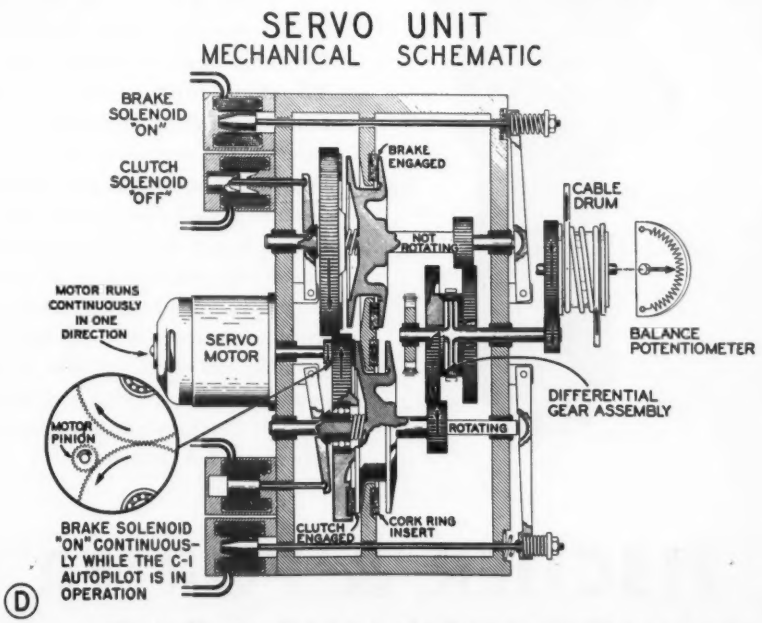

Fig. 6. Schematic drawing of mechanical servomotor transmission.

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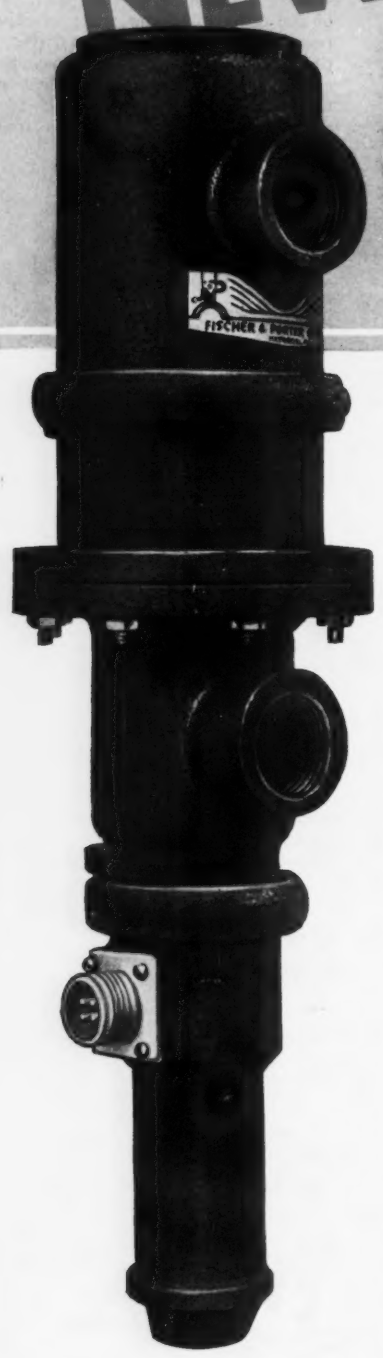

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jectionable. If a rectilinear motion is wanted, the simple reversible motor and gearing can be worked into a long screw and motor-driven nut as is used at present in some landing-gear actuators. For a control surface requiring forces of the order of those mentioned before (10,000 lb. ft.), economy of design can be accomplished by building the system for inverse torque-speed characteristics.

A type of linkage that will provide an inverse torque-speed performance is shown in Fig. 7. In this system, if the motor drives the thrust rod at constant speed, the angular velocity of the control surfaces will be inversely proportional to the tangent of the angle between the toggle arms and the thrust rod. The force on the control surface is a function of the angle approximating a proportionality somewhere between the sine and tangent of the angle. This type of linkage is a natural solution of the force problem involved, particularly in view of the fact that the maximum velocity of the control surface would be wanted at the small angles. A relatively slow motion at the large angles is permissible for practical operation, and it is desirable to avoid unnecessary accelerational stresses at the large angles.

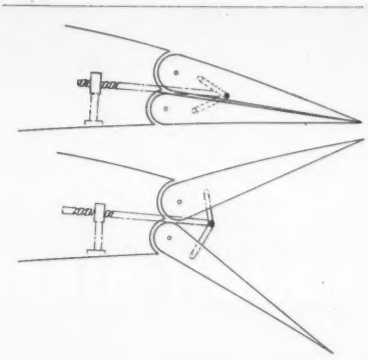

Fig. 7. Inverse torque-speed toggle linkage for control surfaces.

Aerodynamic Actuation

In addition to the mechanisms already described, the "flying" tab can be used as the actuator with a small motor in control of the tab. This is less likely to be widely adopted than the full strength servomotor system because it is less stable. Also there are some surfaces that cannot be controlled by tabs. This is the situation in the large and heavy control surfaces contemplated in the hypothetic plane mentioned above.

Control Surface Forces

It is, of course, impossible to forecast the exact trend in airplane design, but it is reasonable to expect builders to prefer designs in which control surface forces are as small as practicable. The 10,000 lb. ft. forces mentioned probably will not be often repeated even though actually built into some experimental airplanes. Accordingly, for purposes of discussion, this loading may be considered as a top figure for the time being. In this design, it has been contemplated that 1 sec. would be allowed for the control surface to go from zero to full torque and back to zero. The power required for this cycle of operation is estimated at somewhat less than 15 hp.

System Efficiencies

In actuating systems of this size, efficiencies are more important than in the smaller installations now in use. This will restrict the actuating mechanism to hydraulic systems with small no-load losses and to the low-loss electrical systems. The weight and vulnerability of long high-pressure lines, as well as some considerations of flexibility, may be expected to result in preference for electrically driven individual actuators controlled electrically from the cockpit. These conditions will tend to restrict the design to the following systems used either with self-synchronous or potentiometer control circuits:

(1) Electric motor-driven constant-volume pump, constant-pressure accumulator, and cylinder actuator.

(2) Electric motor-driven variable-volume pump and constant volume motor or cylinder actuator.

(3) Electric motor, continuously running with reversible gearing and clutches.

(4) Reversible electric motor and simple gearing.

The efficiency of pumps at full load is stated by manufacturers to be between 85 and 90 per cent. At half load the efficiency may drop to about 40 or 50 per cent. The full-load efficiency is comparable with good electric motor efficiency, but the electric motor may be more efficient at light load than the pump. The efficiency of the hydraulic motor may be estimated the same as that of the pump. In comparing the efficiency of operation of these systems, the total power input is more illuminating than statements of efficiency. This is because these systems necessarily operate much of the time at no-load, when the overall efficiency is zero, although the no-load input is a definite power.

The efficiency and losses of these systems vary materially with the horsepower of the units. The efficiency of 400-cycle squirrel-cage motors for aircraft use varies from 60 per cent for a 0.1-hp. motor to 90 per cent for a 30-hp. motor. A 5-hp. unit with full-load efficiency of 87 per cent for the electric motor at full load is a good size for comparing typical systems. Expressing the performance in terms of power input for various outputs of a 5-hp. unit, rough estimates are given in Table 1. The efficiencies of the two hydraulic systems, (1) and (2), are for this rough estimate assumed to be equal in the absence of precise data.

If these machines were to be compared for use in an airplane of the hypothetic type mentioned, approximately ten 5-hp. units would be required. These units would be designed on the basis of operation for 1 sec. out of each 5 sec. The power required for each unit of the several systems in such a duty cycle would be somewhat as shown in Table 2.

In the next to the last column (Table 2), the average kilowatt input to the system are given and in the last column the average motor losses are shown. The full-load kilowatts (second column under full load) is the requirement the unit makes on the installed generator capacity of the airplane. The average load for the cycle determines the fuel needed for generating the electrical energy for operation. The average motor losses determine the dimensions of the motor required for cooling.

On the basis of losses, the intermittently operated electric motor has all the advantages. The only apparently serious disadvantage of that type of drive is the effect of the starting transients in the electrical system. Whether this can be accepted by the electrical system of the airplane is questionable, but it is probable that, by proper design of starting devices and the use of high-resistance, high-torque motors, starting transients can be restricted to acceptable values.

The intermittently operated motor has an important advantage of weight over those required to run continuously. The effect of the average motor loss of 0.8 kw. on the size of the motor is to require the continuously running motor to dissipate only a little less heat than a 5-hp. motor running continuously at full load. The motor loss of 0.16 kw. corresponds to a continuously running motor of about 1 hp. This permits the design of the motor to be as small as the maximum torque required will permit. If the maximum torque corresponds to the normal full-load torque of a 5-hp. motor, the motor need be only as large as a normal 2-hp. motor operating at two and one-half times rated full-load torque.

Weight Considerations

These variations in operating efficiencies and conditions are reflected in corresponding variations in weight, both of equipment and gasoline carried by the airplane. The weights of the equipment for the four types of installation are not readily available for estimation, especially where the weight is influenced by the nature of the coupling

Table 1

System	Kilowatts Input — Full load, output 5 hp.	Half load, output 2½ hp.	Quarter load, output 1¼ hp.	No load, output zero
Hydraulic (1) and (2)	10.1	6.4	4.2	1.7
Electric (3)	8.2	4.6	2.9	1.2
Electric (4)	8.0	4.4	2.7	0

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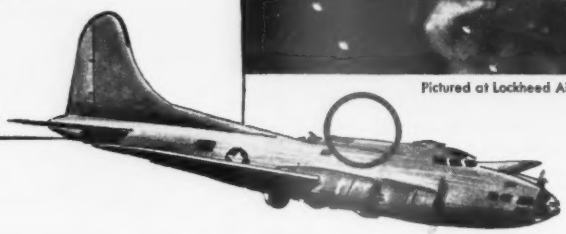

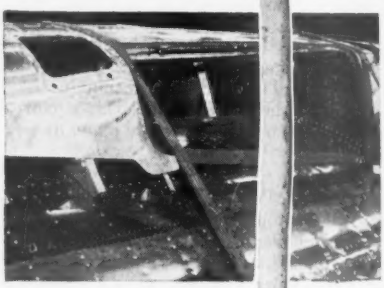

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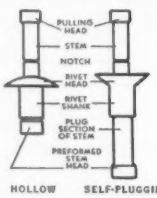

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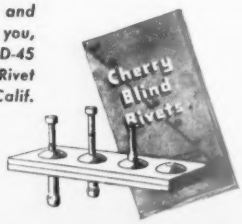

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TABLE 2

System	Full Load Sec.	Full Load Kw.	Full Load Kw. sec.	Half Load Sec.	Half Load Kw.	Half Load Kw. sec.	Quarter Load Sec.	Quarter Load Kw.	Quarter Load Kw. sec.	No Load Sec.	No Load Kw.	No Load Kw. sec.	Total Cycle Kw. sec.	Total Cycle Kw. av.	Total Cycle Electric motor av. losses, kw.
Hydraulic (1) and (2)	0.3	10.1	3.0	0.4	6.4	2.6	0.3	4.2	1.3	4	1.7	6.8	13.7	2.7	0.8
Electric (3)	0.3	8.2	2.5	0.4	4.6	1.9	0.3	2.9	0.9	4	1.2	4.8	10.1	2.0	0.7
Electric (4)	0.3	8.0	2.4	0.4	4.4	1.8	0.3	2.7	0.8	4	0	0	5.0	1.0	0.16

to the control surface. However, it can be stated with assurance that the weight of the reversible electric motor system with direct mechanical drive will weigh less than the other types of systems. These weights, however, are of less importance than the weight of the fuel the airplane must carry for generating the energy required.

In the extremely large airplane mentioned, the average actual control load on a long flight would be less than that based on a 1-sec. out of 5-sec. cycle of operation; but the decrease in duty will be more favorable to the reversible motor (4) than to the systems in which the motors have to run continuously, even if at light loads. In a 10-hour mission, the airplane with ten 5-hp. units would, based on the 1- in 5-sec. cycle, have to furnish for the several systems the amounts of energy shown in Table 3.

These figures do not include gasoline for carrying the weight of the machinery. Gasoline requirements are based on 0.01 lb. of fuel per hour per pound of weight carried, and 1.1 lbs. of fuel per kilowatt-hour generated.

CONCLUSIONS

The conclusions to be drawn from these data are, of course, incomplete, but the status of the problem can be summarized as follows: (1) The remote control of control surfaces can be accomplished by using electric circuits of types already in use: the self-synchronous and potentiometer systems.

(2) The self-synchronous system has apparent possibilities of the nearer approach to perfection.

TABLE 3

System	Kw., Av. per 5 Kw.	Kwhr., Av. for 10 Hr.	Gasoline for Energy, Lbs.	Gas to Transport Gas	Total Gas, Lbs.
Hydraulic (1) and (2)	2.7	270	300	30	330
Electric (3)	2.0	200	220	22	240
Electric (4)	1.0	100	110	11	120

(3) The actuating mechanisms can be developed utilizing already developed hydraulic systems and electromechanical systems based on standard practice.

(4) The hydraulic systems are already highly developed but have disadvantages of the use of fluid and high pressure lines.

(5) A reversible electric motor with a simple mechanical drive offers the possibility of the utmost efficiency and the least weight, but with a disadvantage of starting transients in the electrical system. The choice of the reversible electric motor in preference to less efficient systems depends on the ability of the electric system of the airplanes to accept repetitive starting transients in operation.

The experience in electric generating and distributing systems in general has been that, as the systems increase in size, starting transients become relatively less important. This experience probably will be repeated in aircraft, and it is likely that the simplest and most efficient systems of control will, properly coordinated with the electrical systems as a whole, tend to the exclusion of less efficient and more vulnerable systems.

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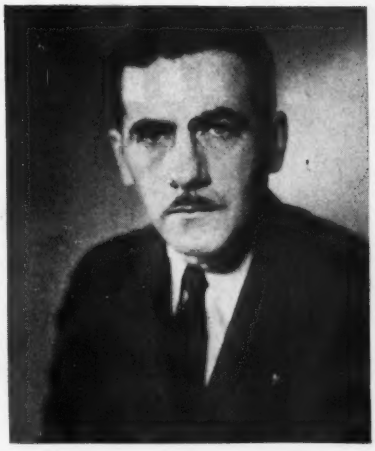

Introduction

The airplane, like so many other mechanical devices, has increased in complexity over the years in direct proportion to its increase in utility. Those of the Wright Brothers and others for some years after were extremely simple mechanisms. From a technical point of view, they were easy to operate, even though the primitive state of their aeronautical design required a high degree of physical coordination and skill to fly them.

The transition from such simple aircraft to the complex types of today has been brought about by the ever pressing demand for greater utility. The first World War provided an initial stimulus that brought about advances in design and performance that normally would have taken 12 or 15 years.

For some years after the war, with development turning to commercial rather than military utility, the same trends continued in slightly changed form. As might be expected, such factors as reliability, comfort, load-carrying ability, and range were the primary objectives.

Until the early 1930's, however, advances in design were quite orthodox, such as increased size, increase in power of engines, use of additional power plants per airplane, and a gradual refinement in structural and aerodynamic design. To the pilot such an orthodox development became almost net gain, since with all these improvements the aircraft called for little more knowledge of operating or pilot techniques than those of earlier years.

The lean years of the depression combined with the sharp increase in air-transport competition, however, resulted in marked changes in aircraft development. The heretofore accepted approach finally failed to provide an answer to the demands for increased speeds and operating utility. Accepting the challenge, design engineers were not long in providing airplanes that almost overnight rendered obsolete the aircraft that were so long the accepted standard. With the advent of the familiar Boeing 247, the DC-2, and, soon after, the DC-3, transport aircraft suddenly became aerodynamically streamlined. In like fashion the few new military aircraft designed tended to follow the same pattern. Such advances were not made without some sacrifice. Structure, as well as operating techniques, necessarily became more complex with the adoption of retractable landing gear, wing flaps, engine cowls, cowl flaps, and other items that were necessary to permit the high degree of performance attained. At the same time, additional power plants of higher power and greater efficiency added to the complexity of airplane operation.

This rapid transition of airplane and power-plant design automatically revolutionized pilot techniques. That elusive quality, "inherent flying ability," formerly used as a criterion, rapidly succumbed to a demand for new and more scientific methods of flight technique. While many rebelled, the handwriting on the wall soon became plain for all to see—namely, that the utility of aircraft is governed not only by the excellence in the design of the aircraft itself but equally so by the knowledge and skill with which it is operated.

Today's airplanes are complex only because it is necessary to have some degree of complexity to achieve the advanced performance that is demanded. If there is an increase in flight instruments, it is to make possible safer flight under all types of operating conditions. If there are increased radio facilities, it is to achieve better communications and navigational control. Likewise, retractable gear and other refinements in the interest of streamlining allow greater speed and range without sacrifice of power. High-speed airplanes, in turn, require wing flaps and other refinements as compensation. Greater power per engine and multiengined equipment mean better loads, performance, and range. All this is paid for by requiring more knowledge and skill from the flight crew if optimum results are to be achieved.

The average inexperienced pilot, and sometimes those with experience, do not always recognize the need for knowledge of proper operating methods. All too often there is a tendency to view the additional accessories or controls of a modern airplane merely as additional complications designed to harass the pilot rather than to give him an airplane with greater operating possibilities. It is in the control of engine power that this attitude is most noticeable. Many pilots are likely to look upon the additional engine instruments and controls as extra burdens imposed upon them thoughtlessly by the power-plant designer. They fail to recognize that the modern power plant provides operating possibilities formerly unattainable and that the many controls and instruments are not always so many "gadgets" but rather an exact means of allowing the power plant and the airplane to be operated at peak efficiency.

Economic Motive for Power Control

With the extreme flexibility of modern aircraft from the standpoint of performance, some guide must be provided the flight crew so that the airplane will be operated at the speeds and powers deemed most advantageous in meeting the demands of the existing operating conditions. Such a guide is commonly thought of as a cruise-control procedure.

It is not possible to design one standard cruise-control procedure to fit all conditions of operation or different types of airplanes with equal efficiency. While this might be possible if the only factor to be considered were to operate the airplane at maximum fuel economy, a great number of economic factors, in addition to fuel economy, are introduced when an air-line operation is considered. Fuel economy with resultant gain of pay load per trip will often exert a comparatively minor influence in the choice of cruising speeds and powers when weighed against the several factors of distances, schedule frequency, the size of the air-line fleet, maintenance, crew costs, and other related overhead. Thus, as demonstrated by domestic air-line practice with the DC-3, it is usually desirable, when possible, to operate a fleet of airplanes at speeds and powers considerably higher than those for optimum fuel pay-load ratio.

Until recently, aircraft available for transoceanic flight distances have necessitated the selection of compromise cruising speeds and control procedures with more emphasis on fuel efficiency than speed. This was necessary so as to achieve a ratio of pay load to fuel load which would render the operation feasible. In some instances, notably ferrying of military aircraft, it has been necessary to favor optimum fuel efficiency. In the final analysis, however, the selection of a cruise procedure depends largely upon the airplane involved in relation to flight distance and con-

Presented at a meeting of the New York Section of the Institute of the Aeronautical Sciences, October 13, 1944.

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sidering *all economic factors* in addition to fuel economy. It is expected that aircraft available for postwar service on a commercial basis will have sufficient load-carrying ability and range in relation to transoceanic distances to favor the use of higher cruising speeds rather than optimum fuel efficiency. In other words, with aircraft of size and performance designed for transoceanic distances we can expect the several economic factors governing cruising procedures of present domestic fleets to be equally applicable to transoceanic service.

It is evident from even a brief discussion of the problems involved in the selection of a power- or cruising-control procedure for any combination of aircraft and operation that the several economic advantages of speed must be given the same attention as efficiency in terms of fuel consumption. This naturally renders the whole subject much more complex than is often appreciated and with the final answer greatly influenced by the problem peculiar to each operation. Since it is beyond the scope of this discussion to attempt an economic approach to air-transport operation, we will confine all subsequent discussion to the more clearly defined aspects of cruise-control techniques now in use.

Basic Concepts of Aircraft Operation

From the *standpoint of fuel efficiency alone*, any airplane is being operated at optimum efficiency when greatest mileage is being achieved for each pound or gallon of fuel consumed. This type of operation is commonly termed maximum range and may be considered as giving a basic set of operating conditions from which any other type of cruise control may be derived.

To operate at optimum fuel efficiency, three different factors must be considered. These are: (1) aerodynamic efficiency; (2) propeller efficiency; (3) engine efficiency.

Aerodynamic Efficiency

Maximum aerodynamic efficiency is always attained by flying at an angle of attack for the wing which provides the best ratio of lift to drag for the complete airplane. For any particular airplane, this optimum angle is attained by determining the required indicated air speed* to achieve the best L/D ratio. In the lift equation $L = C_L qS$, for level flight, and W (weight) may be substituted for L (lift). Likewise, for a given airplane the lift coefficient for the best L/D and the wing area will be constant, so that the equation $L = C_L qS$ may now be written $W = K_q$ where $K = C_L S$ = constant.

Making these substitutions, the formula may be written $q = W/K$. This means that the value of impact pressure must vary in relation to aircraft weight and, since impact pressure is proportional to the indicated air speed, it follows that for any given weight of the airplane there is only one indicated air speed that will maintain the airplane at the angle of attack for maximum L/D. Since this relationship exists, it is possible to specify the indicated air speed for various gross weights.

* Herein defined as the air-speed indicator reading corrected for instrument and installation error.

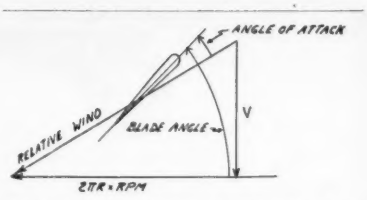


Fig. 1. Vector diagram of a propeller blade section moving in an air stream.

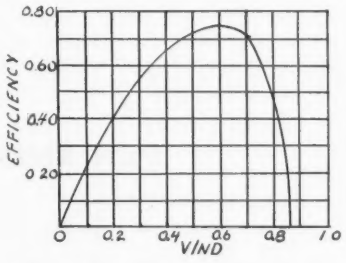


Fig. 2. Typical efficiency curve for a fixed-pitch propeller.

Propeller Efficiency

The aircraft propeller may, for convenience, be considered merely as an airfoil. Therefore, it also should be operated at the best angle of attack in order to obtain optimum propeller efficiency.

The problem is complicated somewhat by the fact that the propeller is rotating as well as moving forward through the air. Thus the resultant velocity of the "propeller airfoil" becomes the vector sum of its forward velocity and the speed of rotation. Therefore, for a fixed-pitch propeller the angle of attack becomes a function of forward velocity, r.p.m., and diameter (see Fig. 1).

Since propeller efficiency is governed by angle of attack, it follows that it is also dependent upon the relationship of V to r.p.m. and diameter. This ratio is commonly expressed as V/ND where N = r.p.m. Fig. 2 shows a typical propeller efficiency curve for a fixed-pitch propeller.

It will be apparent in the relationship V/ND that D may be considered a constant for any one propeller. The efficiency will vary only with variation in velocity (V) and r.p.m. In other words, this means that there is only one r.p.m. that will give maximum propeller efficiency with a given velocity. For a fixed-pitch propeller this limits the attainment of optimum performance to one condition of flight whereat the ratio V/ND gives the optimum angle of attack at the selected blade angle. Therefore, such a propeller is usually selected with a pitch to give optimum performance under one condition. This may be for take-off, climb, normal cruise or high speed. If the pitch selected gives optimum results for any one of these conditions, it is automatically less efficient for the others.

It was this limitation of fixed-pitch propellers that demanded and ultimately led to the development of the present-day constant-speed propellers. With such propellers the pitch can change with variation in r.p.m., horsepower, altitude and true air speed. This means that the constant-speed propeller may be considered as an indefinite number of fixed-pitch propellers with the proper pitch being always attainable for any condition of flight. A propeller efficiency curve can thus be constructed for any number of selected blade angles (see Fig. 3).

From this it will be apparent that, once the blade angle has been fixed, there can be only one value of r.p.m. for a predetermined air speed at which maximum propeller efficiency can be attained.

While the constant-speed propeller greatly simplifies the problem of attaining maximum propulsive efficiency, it is of interest to note the influence of the several variables concerned. These are: r.p.m., power output of the engine, true air speed, and altitude.

By assuming a *constant altitude and horsepower*, propulsive efficiency becomes a function of air speed and r.p.m. (see Fig. 4). From this figure it will be apparent that, as the true air speed increases from 150 to 200 m.p.h., the engine r.p.m. for maximum efficiency should be decreased from approximately 2,000 to 1,700.

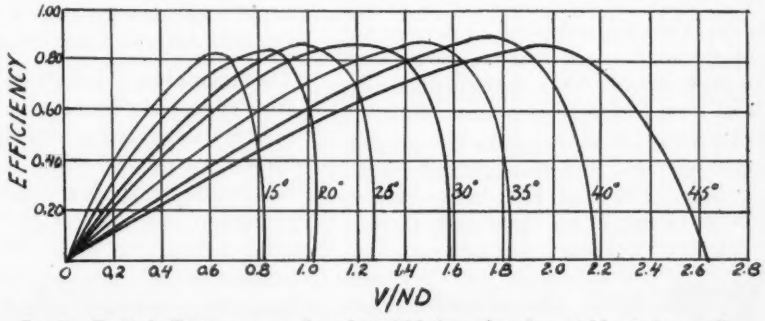
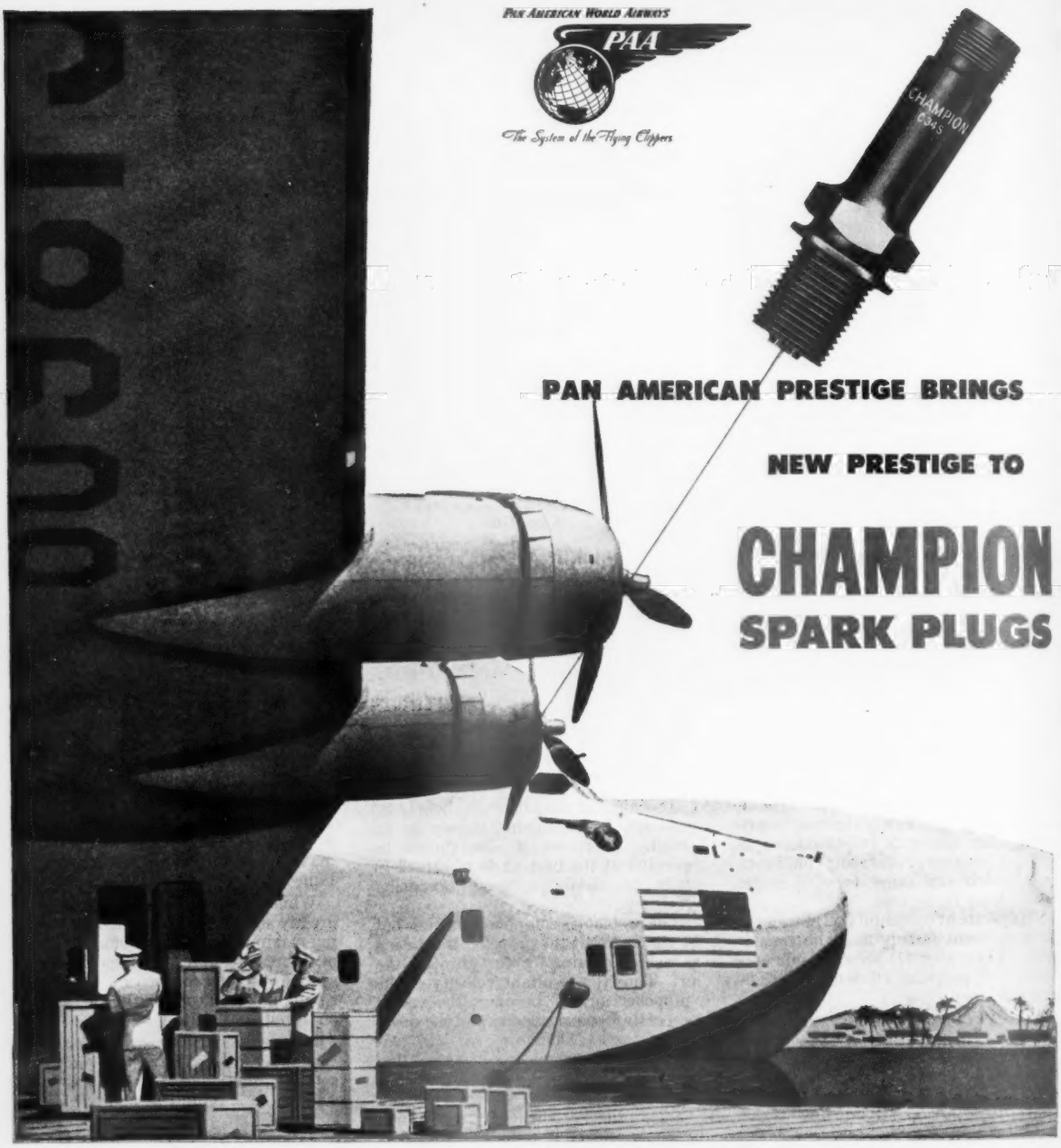


Fig. 3. Typical efficiency curves for selected blade angles of a variable pitch propeller.



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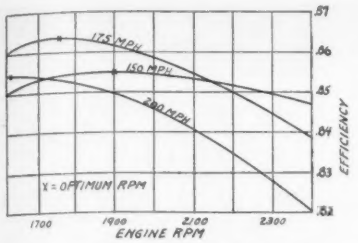

Fig. 4. Propulsive efficiency versus engine r.p.m. for various air speeds with constant altitude and horsepower.

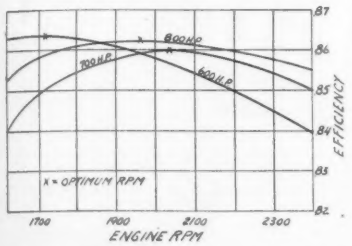

Fig. 5. Propulsive efficiency versus engine r.p.m. for various horsepowers with constant altitude and air speed.

Fig. 5 shows how r.p.m. for maximum efficiency varies with horsepower. In this instance *altitude and air speed are constant.* Optimum r.p.m. for peak efficiency increases noticeably with increase in horsepower. The fact to be noted is that a constant-speed propeller allows achievement of almost uniform propulsive efficiency provided the proper r.p.m. is used.

Fig. 6 shows the variation of propulsive efficiency with engine speeds for various altitudes assuming a *constant power and air speed.* Note that with a selection of proper r.p.m. a high value of propulsive efficiency can be maintained over a wide variation in altitude.

It will be evident from the foregoing discussion that propulsive efficiency can be held to within about ±1 per cent of optimum throughout a wide range of air speed, altitude, power and engine r.p.m. with a constant-speed propeller. The pilot can maintain control over this factor if he is provided with cruising-power procedures specifying the proper r.p.m. for the desired combination of power, altitude, and speed.

Engine Efficiency

The best index of engine efficiency in practical operations is the amount of fuel that an engine will consume in producing 1 hp. for a given period of time. This is termed *specific fuel consumption* (s.f.c.).

While any given power may be developed by an engine with any one of numerous combinations of r.p.m. and manifold pressure, engine efficiency in terms of s.f.c. will differ with each combination.

Basically, any internal-combustion engine can be likened to an air pump. The amount of power developed at any time is determined by the amount of fuel-air mixture (by weight) that can be burned in a given time. Several variables that determine this are present: (1) The revolutions per minute. (2) The manifold pressure, which is simply the pressure of the combustible gases entering the cylinders. (3) The density of the atmosphere in which the engine is operating. (4) The carburetor air temperature. (5) The fuel-air mixture. (6) The fuel density.

While each of these variables must be considered in actual operation in determining the power output, we may for the sake of simplicity in discussion consider the latter four variables as indirect influences on power in that their variation must be compensated for by changing the value of manifold pressure. By assuming standard sea-level pressure and temperature, normal fuel density, and the correct fuel-air ratio, the development of a given power becomes primarily a function of r.p.m. and manifold pressure.

Since there is always a certain percentage of the i.hp. developed in the engine which must be used to overcome friction in motoring the engine and driving accessories, the b.hp. is always less than the i.hp. It follows that the faster the speed at which the engine is operated, the greater is this loss in friction horsepower. Therefore, from this standpoint it is advantageous to develop a given power with the least number of r.p.m.'s. Refer to Fig. 7 on which s.f.c. is plotted against engine r.p.m. for various powers. As engine speed is reduced, a greater weight of fuel-air mixture must be burned with each revolution in order to develop a given power, that is, manifold pressure must be increased to maintain a given power.

This process of raising engine efficiency by lowering r.p.m.'s and raising manifold pressure has a definite limit. For most American radial aircraft engines, the design b.m.e.p. is approximately 140 lbs. per sq.in. Thus, manifold pressure and r.p.m. combinations should not be used which exceed this limit. Because manifold pressure for any horsepower is influenced by the several variables listed, a minimum r.p.m. is usually specified for any horsepower rather than a maximum manifold pressure.

The calculation of the minimum r.p.m. that can be used in developing any horsepower is comparatively simple. It may be accomplished on any pilot's calculator. From the basic power equation b.hp. = PLAN/33,000 we may derive a practical relationship. This becomes b.hp./r.p.m. = b.m.e.p./K, where K = engine constant.

The constant for any engine may be found by dividing 792,000 by the engine piston displacement as given by the manufacturer in the model number (example: Pratt & Whitney R-2000).

Selection of R.P.M.

It has been shown that r.p.m. is a major factor not only in propeller efficiency but in specific fuel consumption.

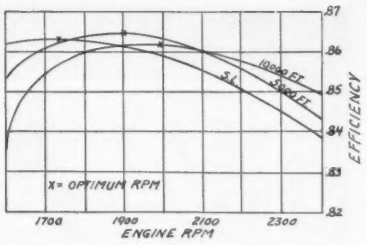

Fig. 6. Propulsive efficiency versus engine r.p.m. for various altitudes with constant air speed and horsepower.

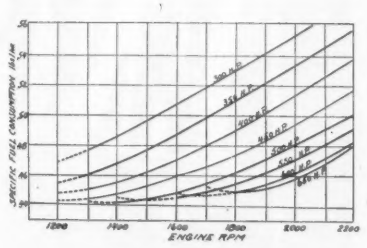

Fig. 7. Specific fuel consumption versus engine r.p.m. for typical engine with auto lean mixture and low blower.

It should be apparent that for efficient long-range operation, propulsive efficiency should be at a maximum and specific fuel consumption at a minimum.

The range of the airplane will vary directly as the propulsive efficiency and inversely as the specific fuel consumption.

Unfortunately, it is seldom that maximum propulsive efficiency is obtained with the same r.p.m. as minimum specific fuel consumption. In other words, one r.p.m. may be dictated for maximum propeller efficiency while a different r.p.m. is dictated for maximum engine efficiency. While this situation differs in different airplanes, some degree of compromise is normally necessary.

Assuming that η = propeller efficiency and c = s.f.c., an r.p.m. should be selected for each operating condition of power, speed, and altitude so that the ratio η/c is a maximum. Fig. 8 shows how this may be presented graphically for any one altitude.

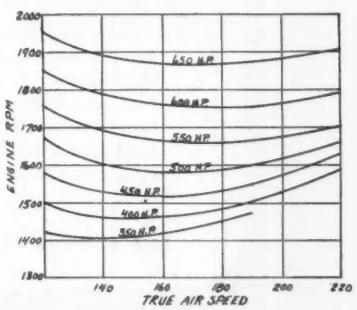

Fig. 8. Engine r.p.m. for best η/c versus true air speed at 5,000 ft. density altitude for typical engine with auto lean mixture and low blower.

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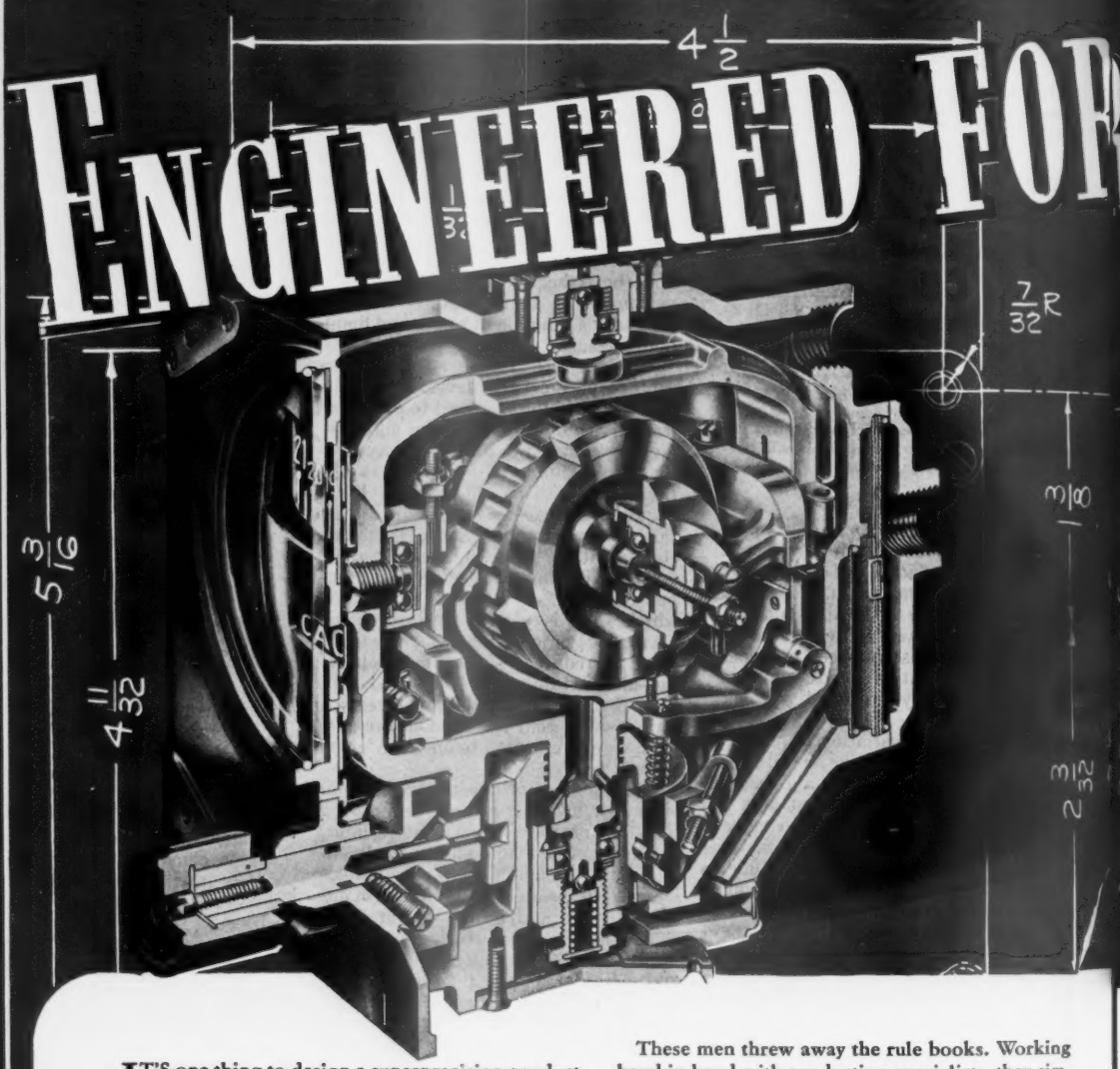

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Flight Testing

While it is theoretically possible to develop final performance figures for an airplane propeller and engine combination by integrating their separate components of performance, such a procedure is seldom practical. Usually it is found that any airplane propeller and engine combination does not achieve in flight the same performance arrived at by engineering analysis. This is because of the existence of numerous variables and sometimes unexpected factors that cannot be anticipated prior to flight testing.

It is not always possible to use flight-test results obtained during the original performance tests of the airplane by the manufacturer as a basis for cruise-control figures to be used in actual service. Usually any airplane undergoes numerous minor modifications between factory and line service.

Since these conditions exist, it is usually found most practical to arrive at final figures of aircraft performance through extensive flight testing of the airplane after it has received final modification for actual operation. For a large airplane such as the C-54 such flight tests may necessitate as much as 150–250 hours flight testing under all conditions of weight, power, speed, and altitude which normally would be used.

Such flight testing must be done under carefully controlled conditions so that accurate figures of speed, power, fuel consumption and engine settings may be obtained. For this purpose it is desirable to install some special equipment on the airplane. It is also necessary to accurately calibrate all instruments such as air-speed indicators, altimeters, manifold pressure gages, tachometers, etc. If automatic carburetors are used, special care must be exercised to adjust them to the fuel-air ratios specified by the engine manufacturer.

Two desirable items of special test equipment are: (1) torquemeters on all engines and (2) an accurately calibrated fuel tank that may be used at any time when precise measurements of fuel consumption are taken.

The use of these two devices eliminates most of the troublesome inaccuracies in obtaining an accurate measure of power and fuel consumption. The torquemeter, for example, furnishes a direct indication of power by measuring the torque delivered to the propeller shaft. This, combined with the r.p.m. and a conversion constant, furnishes an extremely accurate measurement of b.hp. by eliminating the several variables that are always present if b.hp. is calculated from r.p.m. and manifold pressure. The use of a special test tank for fuel consumption, rather than relying upon flowmeters or quantity gages, greatly increases the accuracy of fuel consumption figures.

Basic Performance Curves

From flight-testing results it is possible to arrive at accurate figures for the speed, power, and specific fuel consumption relationships for several representative aircraft weights and density altitudes. An airplane such as the C-54, for example, might be tested at each 5,000-ft. level from sea level to 25,000 ft., and at powers throughout the cruising range of the engines. Additional tests may be conducted above cruising hp.'s and for three-engined operation. Obviously, the more complete performance data desired, the more complex the flight testing becomes.

From such flight-test data, numerous different performance curves can be drawn up. Fundamentally, three forms of performance curves are of interest in the selection of cruise-control data.

A Cruising Hp. Chart

In this the curves of b.hp. vs. indicated and true air speeds for cruising flight are plotted against density altitude. In final stage this takes the form of the familiar cruising horsepower chart. It is usually constructed for an average gross weight of the airplane and a separate correction graph is attached so that it may be used for any gross weight.

Best η/c

Curves are constructed at representative altitudes to show the proper r.p.m. to obtain optimum η/c for any true air speed. From these, of course, we are able to choose the proper r.p.m. giving the best compromise between propulsive efficiency and specific fuel consumption for any combination of hp. and true air speed.

Miles versus Fuel Curves

At representative altitudes and weights, curves are plotted showing miles per pound of fuel consumed against true or indicated air speed. Such a representation is shown in Fig. 9.

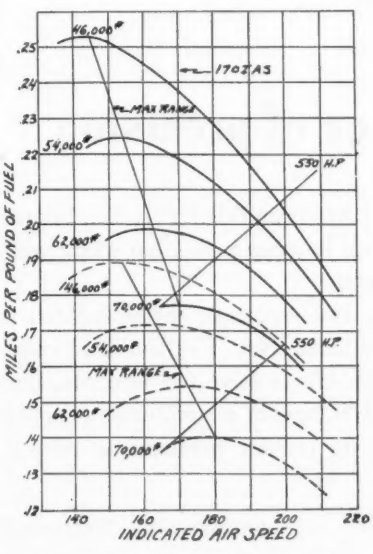


Fig. 9. Fuel efficiency for a typical airplane at 5,000 ft. density altitude in terms of miles per pound of fuel versus indicated air speed. Solid curves are for zero wind conditions and broken line curves are for a 40 m.p.h. head-wind condition.

Basic Systems of Cruise Control

Cruising-control systems generally take the form of one of three basic systems. These are commonly termed maximum range, constant indicated air speed, and constant horsepower.

As defined previously, *Maximum-Range Cruise Control* is a method of maintaining the airplane at the optimum speeds and operating the engine-propeller combination at the optimum settings so that maximum mileage per pound of fuel is achieved.

Constant Indicated Air Speed is a method of operating the airplane continuously at a certain indicated air speed with optimum power settings. Such an air speed may be selected in order to approximate maximum-range fuel economy or may be chosen at some compromise speed between maximum range and maximum cruise.

Constant Horsepower Cruise Control prescribes the selection of a definite power at which the engine will be operated throughout cruising flight. Such a power may be selected to approximate maximum range or to give a high average cruising air speed.

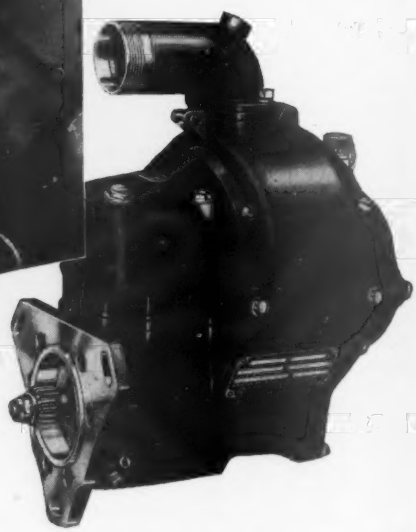
Fuel Efficiency

By a brief analysis of Fig. 9 some comparisons can be made of these systems in terms of flight efficiency on the basis of miles per pound of fuel consumed. In this figure are plotted curves for four representative weights showing miles per pound of fuel consumed against indicated air speed. These are plotted against zero wind and −40 wind conditions at 5,000-ft. density altitude. It will be noted that each curve of miles per pound reaches a peak at a definite range of air speeds and drops off from this peak as the air speed is either increased or lowered. By selecting the peak of each curve, we have also selected the optimum or maximum range air speed for that weight under the conditions of altitude and wind specified. Drawing a straight line through these points of maximum miles per pound, we may obtain the maximum range air speeds for any weight by interpolation. Two facts should be noted. These are:

(1) The air speed for maximum range progressively decreases as the gross weight of the airplane decreases.

(2) For this particular airplane the peaks of the curves are comparatively flat—and we could pick maximum range air speeds 10 or more miles faster than those given by the absolute peak with practically no loss in fuel efficiency. This is true for most large airplanes. It simply means that maximum range air speeds are not critical.

Also shown in this figure is the fuel efficiency that would result if constant indicated air speed of 170 m.p.h. were used. At 5,000 ft. this would result in a true air speed of 183 m.p.h. It will be noted that at the high gross weights such a constant air speed will be almost as efficient as the maximum range speeds; but as gross weight decreases, the efficiency of a constant air speed



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drops off progressively. For this particular airplane, however, at the altitude and wind conditions specified, the loss of efficiency with a constant 170 indicated air speed is negligible. This is particularly so when it is considered that this airplane is customarily operated between 65,000 and 50,000 lbs. gross weight.

The fuel efficiencies resulting from a constant 550-hp. operation are also shown. It will be evident that at the higher gross weights the fuel efficiency closely parallels the other two systems of operation. At the lower gross weights the efficiency begins to drop off rapidly. Again, in the normal operating weight range of this particular airplane the loss of efficiency is not serious, while an appreciable gain is obtained in true air speed.

Maximum-range power control possesses certain advantages from the standpoint of efficiency not inherent in the other two systems. These are:

(1) Flight efficiency in terms of miles per pound of fuel can be maintained practically constant throughout the normal operating altitudes of an airplane. It is difficult to choose a single power that will approximate this condition due to the wide range of indicated (and true) air speeds that will result with changes in altitude. Not only will the fuel efficiency vary but often the air speeds are unsuitable for practical operation. A similar difficulty exists with a single constant indicated air speed. At high altitudes it may be impossible to obtain the air speed without exceeding the maximum cruising power of the engine and secondly, the efficiency in terms of miles per pound will vary.

(2) Maximum-range cruise control provides for an increase of speed as compensation for head-wind conditions. By constructing the miles per pound curve against indicated air speeds for various increments of head wind, it can be seen from Fig. 9 that the speeds for maximum range against wind should be increased over those specified for zero wind conditions. This increase should be approximately 20 to 25 per cent of the effective wind with the exact value varying for different airplanes. By increasing the air speed in this manner, maximum-range cruise control still provides the optimum possible fuel efficiency when confronted with head winds. Thus, although it is a slower flight operation with light winds than either of the other two systems, it may become a faster method of operation when head winds are encountered.

Selection of a Cruise-Control Procedure

Although it might appear from the foregoing discussion that the inherent advantages of a maximum-range cruise-control system from a fuel efficiency point of view would lead to general acceptance, numerous practical considerations make the selection of a cruise-control procedure a point of considerable controversy.

As previously emphasized, many factors other than the purely technical aspects are introduced in practical operations to influence such a choice. Since many of these factors influence different operators in different degrees, it is not too surprising that everyone has not arrived at a similar choice of cruise procedure.

Pros and Cons of Cruise-Control Methods

Maximum Range

Regardless of other factors, a maximum-range cruise-control procedure is the most efficient method for fuel economy for long-range flight. As the flight length increases, so does maximum-range efficiency increase over other procedures. Thus it can be used to advantage under several conditions:

(1) When flight distance is so great that less efficient methods of operation cannot be used with safety.

(2) When the existence of head winds over a route makes this a more practical operation than other methods.

(3) When it is deemed more advantageous to carry maximum pay load rather than to save time.

(4) When fuel is at a premium.

(5) As an emergency procedure.

Maximum-range cruise-control has certain disadvantages that make it unsuitable to most operators for normal conditions. Some of these are:

(1) On the average, it provides a slower flight operation. This is a serious limitation from an overall economic point of view.

(2) In flight it is difficult to achieve the theoretic advantages of the procedure. While it is not too difficult to vary the air speed with variation in gross weight, it is often impossible to compensate for variable winds with any degree of efficiency.

(3) Because of the number of variables involved, it is difficult to design a simple cruise-control guide for the flight crews.

(4) Flight planning is complicated.

Constant Air Speed

A constant air-speed cruise-control method very likely has been the most widely used system for long-range operation. Several factors favoring its use are:

(1) Maximum-range fuel efficiency may be closely approximated if a proper air speed is selected.

(2) For the normal weight and altitude range of most airplanes, one air speed will suffice; but if it does not, a variable air speed can be selected with altitude without seriously complicating the procedure.

(3) Since most long-range operations have been conducted over routes where normal winds are not an important factor, a specified air speed has usually resulted in satisfactory fuel efficiency and safety.

(4) The variation of engine power needed to maintain a constant air speed with changes in weight does not present the same difficulties in airplane controllability that are encountered with a constant horsepower control.

(5) For inexperienced crew members maintaining a constant air speed appears to be a simple solution to cruise control.

(6) A constant air speed simplifies flight planning and navigation.

(7) Cruise-control charts for flight crew guidance can be made simple.

Disadvantages are:

(1) It does not provide the flexibility and safety features that a maximum-range procedure provides over routes where extreme wind conditions are often encountered.

(2) Unless the flight crew is provided with cruise-control charts and power calculators whereby the proper power in relation to speed may be ascertained, there is always a possibility that excessive power may be set up to develop the required air speed. In other words, air speed should be controlled by power rather than by using air speed as the primary guide. Trouble in this respect is always a possibility with inexperienced or careless crew members. Numerous conditions can always arise in flight which will upset the trim of the airplane and cause loss of air speed. Correcting for this by application of additional power rather than trimming the airplane is a common offense.

(3) Some airplanes are difficult to maintain at one air speed. This is particularly true if they must be hand flown for long periods of time or if rough air is encountered.

Constant Horsepower

A constant-horsepower cruising system is most often used on the domestic air lines. It has also been used to some extent for transoceanic operations. Some of its advantages are:

(1) For intermediate flight distances where fuel weight consumed is not extreme in relation to the gross weight of the airplane, a constant-power cruise achieves acceptable fuel efficiency. The larger and more efficient the airplane, the greater becomes the absolute distance over which this will apply.

(2) Since engine power is the basic controlling factor rather than air speed, there is less chance that the airplane will be operated incorrectly than with a system based upon air-speed control.

(3) Maintaining a constant power is usually the simplest procedure from the standpoint of the flight crew.

(4) Flight planning is simple.

(5) When the design of the airplane is such that high speed cruising can be used over the distance involved, use of a constant power usually provides the fastest flight.

Some of its disadvantages are:

(1) Compared to maximum range or equivalent constant air speed, efficiency in terms of fuel consumption decreases rapidly when the length of the flight results in a large weight and speed variation in relation to the gross weight of the airplane.

(2) If an intermediate cruising power is selected, the speeds at high gross

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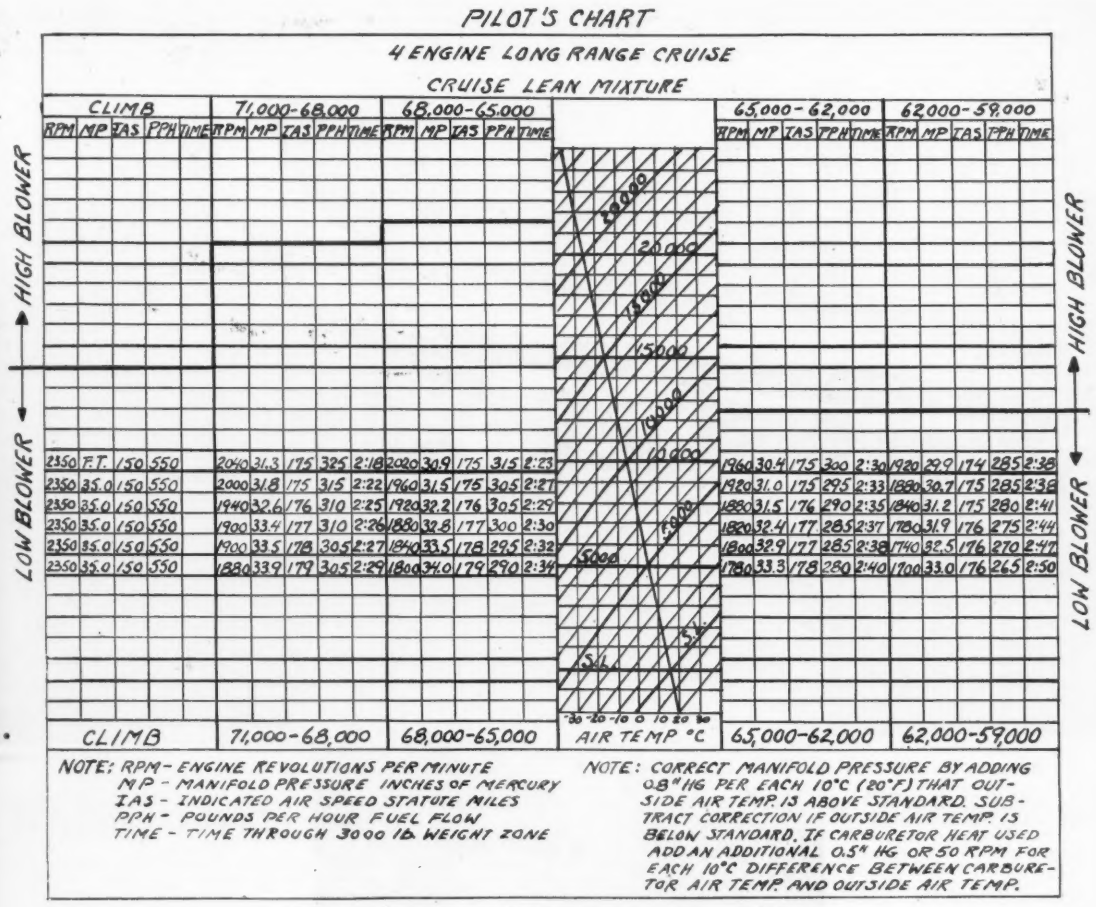

Fig. 10. Example of a tabular long-range cruise control chart.

weights in the early stages of flight are frequently undesirable for airplane controllability.

(3) Variation of indicated air speed with increase of altitude often leads to the same results as noted in No. 2 above.

Compromise Cruising-Control Procedures

In the attempt to realize as many advantages as possible of the three basic cruise-control systems, numerous compromise systems have been evolved. One of the most common compromises has been the adoption of a relatively high speed constant-power procedure for intermediate distances and a modified maximum-range or constant airspeed procedure for long distance operations. This, of course, is in effect nothing more than adopting two cruise-control systems in order to operate the same airplane efficiently over a route the various portions of which are of different lengths.

With recent standardization upon the C-54 for contract carrier transoceanic operation it became desirable, for uniformity of operation, to standardize cruise-control procedures. As a result, by agreement between the various operating contract carriers and military authorities a single compromise cruise-control procedure was agreed upon for this particular airplane. This was arrived at in the following manner:

All existing performance data of the airplane was carefully checked in view of modifications made since the original flight-test data had been compiled, and the absolute maximum range of the airplane was recalculated throughout its operating gross weight and altitude range.

With these basic figures established, it was agreed that the desirable operating speeds were those specified for maximum range against a 50-knot head wind.

Such a system of cruise control offers several advantages and few disadvantages, some of which are:

(1) A reasonably high flying speed is maintained over a route at all times without too great a sacrifice in fuel economy. This satisfies the basic premise that a fast operation gives improved utility considering all factors while at the same time fuel efficiency is acceptable.

(2) It offers the salient advantage of maximum-range cruise control under those conditions when it is most likely to be needed; that is, against high-velocity head winds. This is a real advantage on such a route as the North Atlantic.

(3) From a flight crew point of view it is simple to use. Five different power settings will suffice for approximately 14 hours and the indicated air speed will seldom vary more than 10 m.p.h. Likewise, the indicated air speed always falls within the range deemed acceptable to most pilots for controllability.

Presentation of Cruise-Control Information

In actual practice the method selected for the presentation of a cruise-control procedure assumes large proportions in determining its success or failure. If the presentation is not well thought out and made for convenience both in the cockpit and for flight planning, the most carefully engineered procedure will often be worthless.

Until recently, the accepted method of presenting cruise-control information was by graphs. Sometimes this took the form of numerous pages of graphs showing all the variables of r.p.m., manifold pressure, indicated air speed, true air speed, fuel consumption and horsepower plotted against gross weight. Separate graphs were usually incorporated presenting certain portions of the same information in forms suitable for flight planning. The result all too often

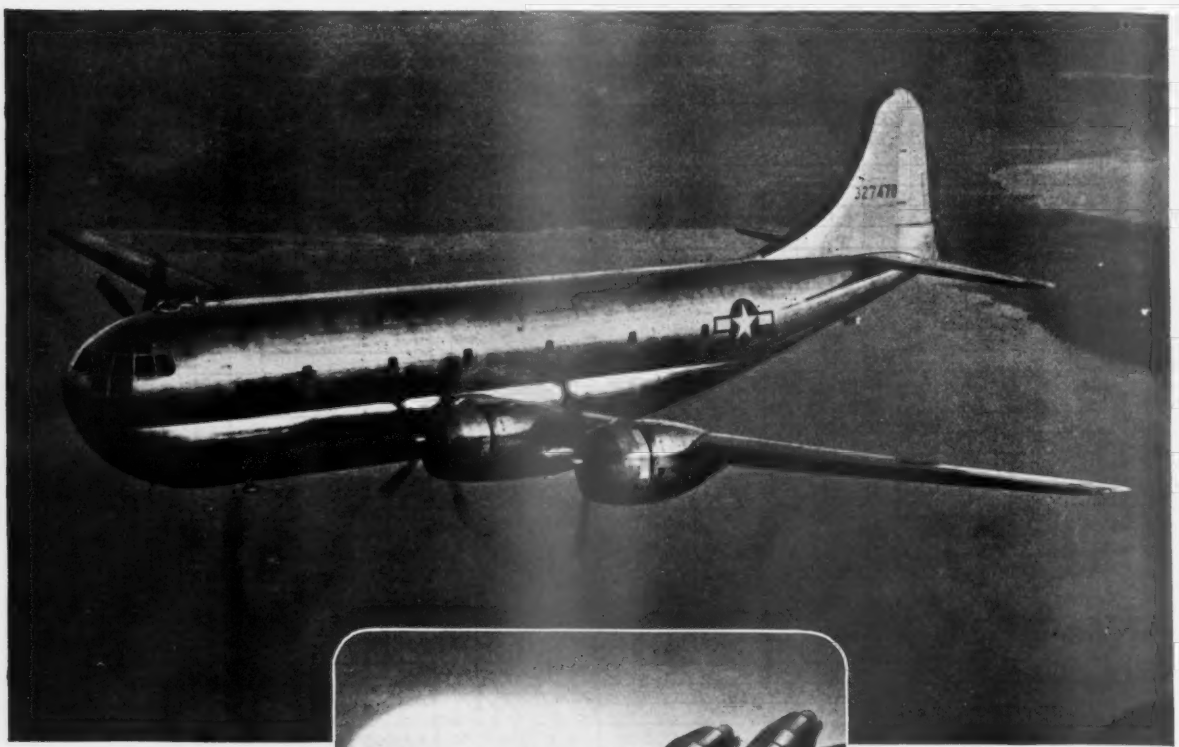

Photo Courtesy Boeing

Above, the new Boeing C-97 Army Transport which exceeds all existing AAF transports in range, pay load, and size.

Left, type of Barber-Colman Control Equipment used to maintain uniform temperature in the C-97 passenger cabin.

BARBER-COLMAN CONTROLS

HOLD UNIFORM TEMPERATURE IN PRESSURIZED CABIN OF C-97

BOEING'S Model 377 Stratocruiser, the postwar version of the C-97 Army Transport, will carry 100 passengers in luxurious comfort, for operating ranges up to 3,500 miles with ample fuel reserves. One feature of this luxury, as already demonstrated in the C-97, is a huge pressurized double-deck cabin maintained at low-level conditions *and uniform temperature* in all weather and at all altitudes up to 30,000 feet or higher. Barber-Colman Controls which provide uniform temperature consist of Power Units on the right-hand and left-hand heat exchanger dampers, the warm air supply from one side being governed by a Micropositioner in the aft cabin space and from the other side by a similar unit forward. A manual switch controls two other Power Units on dampers which can divert the heat supply for anticing, at the same time connecting a Thermostat to prevent excessive duct temperatures. A manual emergency switch transfers the limit thermostat control to either right or left-hand heat supply when needed. The Power Unit circuits also have master on-off-automatic control switches. This is an excellent example of how Barber-Colman Aircraft Controls, specially designed for accuracy, high power, light weight, dependable operation, maximum performance, and minimum maintenance, can be engineered to produce desired results under extreme conditions.

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was a complicated maze that proved discouraging to the average crew member.

While a graphic presentation can be made simple and is still preferred by many, the fact exists that numerous pilots and other crew members are not well versed in the use of graphs. This condition has been accentuated by wartime operation which has forced thousands of comparatively inexperienced military personnel into long-range flying.

The most obvious solution has been to present cruise-control data in tabular form. The Army-Airline presentation of the C-54 control system illustrates this. Referring to Fig. 10, some of the noteworthy features are:

(1) The operating gross weight range of the airplane is divided into 3,000-lb. weight increments. This is equivalent to 500 gal. consumption—a convenient figure.

(2) For each weight increment the values of indicated air speed, r.p.m., manifold pressure, consumption in pounds per hour and weight bracket time interval are listed horizontally for each 1,000 ft. of density altitude throughout the normal operating altitudes of the airplane. This furnishes the pilot with all the information required at any time.

(3) All essential information is contained on 2 pages.

(4) The same procedure is listed on a navigator's form in a manner more suitable for flight planning. The fundamental difference is the tabulation of the true air speed in knots.

Crew Function

The success of any cruise-control procedure in obtaining the type of flight operation desired is directly dependent upon how efficiently it is used by the crew.

The navigator who customarily does the flight planning can exert an important influence upon the ratio of pay load to fuel load by the care and intelligence used in his calculations.

The pilots (in some instances the flight engineer) assume the major responsibility in flight. Care in making power changes when called for and in maintaining the proper power and air speeds is essential. Care in trimming and flying the airplane is also essential. Certain elements in this respect are worthy of note:

(1) *Lateral Attitude*—Carelessness on the part of a pilot may allow the airplane to be trimmed to fly with one wing lower than the other. This results in decreased efficiency of the wing and requires a greater expenditure of power to obtain the specified air speed. In such an attitude also, if the airplane is maintained in straight flight by incorrect trimming, a further loss is experienced by the increased drag of the fuselage. In other words, a correctly trimmed airplane is essential to obtain the performance specified by the cruise procedure.

(2) *Maintenance of Constant Altitude*—Altitude changes, deliberate or otherwise, should be kept to a minimum. It is frequently believed that the speed advantage obtained during descent will offset the loss of the corresponding climb. This is not true because the speed power relationships at high descent speeds and low climbing speeds do not balance. Likewise minor variations of altitude without change in power also result in a loss of efficiency since more time is required to fly a given distance.

(3) *Air Turbulence*—Turbulent air should be avoided whenever possible since it makes it difficult to maintain the proper flight attitude, altitude, and speed. General loss in efficiency results.

(4) *Use of Supercharger*—All modern engines are supercharged by either an internal blower or an exhaust turbo. Many of the more high-powered engines have a two-stage blower. An engine supercharger, whatever the type, requires power for its operation. Therefore, the more supercharging used, the higher will be the fuel consumption for the same power. Thus, whenever possible, a given power should be developed with the least possible supercharging.

Basic Improvements Needed

Two broad avenues of research toward improving aircraft efficiency for long-range flight are clearly indicated by present standards of operation. One of these is improved specific fuel consumption for aircraft engines and the other is the provision of better instruments for the operation of the engines.

The average value of specific fuel consumption in domestic air transport has been approximately 0.45 lb. per b.hp. per hour for normal cruising. It should be possible to improve this figure (even with the same engines) for long flights considering the greater opportunity that exists for operating at lean mixtures. Experience to date does not indicate this result. The possibilities for improving the specific fuel consumption of many of the more recently developed high-powered engines appear to be great. The increased pay load resulting from a 10 per cent improvement in specific fuel consumption for an operation between New York and London can be demonstrated to be worth in the neighborhood of $2,000 per flight.

Improved instruments for power control are also vitally needed. Present methods of calculating power output from r.p.m. and manifold pressure are basically inaccurate since so many variables are present. An accurate horsepower meter would prove an effective solution to this problem. Such an instrument exists although it is not presently available for service aircraft.

Determination of fuel consumption, fuel quantity in the tanks, and fuel-air ratios present some of the most troublesome problems confronting the pilot at the present time.

Fuel quantity gages are worthless in many airplanes but it does not appear that the solution to this problem should be impossible. As a partial solution to this difficulty fuel flowmeters are gaining wide acceptance. This type of indicator measures the actual rate of flow to the engines in pounds per hour, thus furnishing an indication to fuel consumption, and is usually considered accurate to within 2 per cent if properly maintained. To guard against this inaccuracy, however, additional fuel must be carried. For an ocean flight normally requiring 16,000 lbs. of fuel, this would represent a loss of 320 pounds of pay load.

No satisfactory instrument exists at present for determining the fuel-air mixture being furnished the engine. While such instruments have been developed they have not proved too reliable, particularly in measuring the lean mixtures desired for long-range cruising. It would appear that some research is needed on this problem also.

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Service Checking Facilities for All-Weather Transport Operation*

E. A. CUTRELL†

Air Transport Command

Introduction

AVIATION AS A WHOLE has progressed rapidly during the last 15 years, but progress in all-weather operation of aircraft has been slight during the same period. Since 1931, advances made in airplane design, airport construction, accessory development and operating methods have exceeded all predictions. Perhaps instrument flying could have been called advanced in 1931 compared with other phases of aviation. At that time a Pitcairn Mailwing, on an instrument flight from New York to Washington, would make a let-down over a radio-range station for a landing at Hoover Airport. Tomorrow a C-54 on an instrument flight from Stephensville will make a similar let-down over a radio-range station for a landing at Washington National Airport. During the intervening 15 years the operating ceiling and visibility minimums have changed but little. They are still the controlling factor in all aircraft operations. An air line, Air Transport Command, or tactical operating office is organized and revolves around weather sequences and forecasts.

Developments Under Consideration

As early as 1931 the Bureau of Standards had developed a blind landing system comprised of a visual localizer beam, a glide path, and inner and outer markers, very much like the one now adopted as an Army-Navy-C.A.A. standard. Engineers have also spent years on the development of approach and runway lighting for restricted visibility landing. There have undoubtedly been more meetings, programs, papers, conferences, and articles covering the subject of all-weather flight and blind landings than any other one phase of aviation. In addition, the war has brought forth many new radio and radar developments. Today, a committee or a conference has many items to add to the confusion when a "defeat the weather" program is discussed. Some of the items are:

(a) The SCS-51 instrument approach system with VHF or very-high-frequency localizer, glide path, and markers.

(b) The A-1 system of two compass locators or radio beacons for radio compass guidance.

(c) Neon approach lights.

(d) High-intensity approach lights.

(e) VHF radio ranges.

(f) The British Standard Beam approach system.

(g) The Sperry automatic ultra-high-frequency localizer, glide path system.

(h) The omnidirectional range.

(i) The black box.

(j) The G box.

(k) Automatic pulse technique.

There are, in addition, other developments being discussed that may make an important contribution to defeating the weather someway, sometime, someplace.

Nevertheless, the fact still remains, that a C-54, tomorrow, on an instrument flight from Stephensville, is going to make just about the same type of let-down to land at Washington as a Pitcairn Mailwing did in 1931, and with about the same minimum ceiling and visibility limitations.

Why have we not made better progress? It is the author's opinion, that progress in all-weather operation has not advanced because of the omission of one fundamental. In the confusion of conferences, developments, demonstrations, simulated instrument landings, and treatises covering the weather problem, there has not been an adequate service test made *under actual weather conditions*. By adequate service test is meant the operation of airplanes over an airway in all weather conditions; taking off, navigating, and at least attempting landings 365 days a year regardless of minimums. It is important that such service tests be conducted by the same transport pilots flying the same transport airplanes that daily operate in our transport services. Such a service test will define the problem to be solved as it should be defined—from the cockpit point of view. Such a test should present to the engineers an orderly sequence of the requirements necessary for all-weather transport operations.

Service Testing on the Northeast Airway

The Navigation and Landing Aids Unit of the Air Transport Command is conducting a service check of facilities now available and under actual weather conditions. The airway being used is from Washington, D.C., to Presque Isle, Me., where a good cross section of all weather conditions may be found throughout the year.

The facilities installed over this airway include the following:

(1) Army Air Forces Instrument Approach System—i.e., (a) two-course visual VHF localizer, (b) straight line, equisignal zone VHF glide path, (c) 75-megacycle markers at runway boundary, 1 mile and 4½ miles from the approach end of the runway.

(2) The A-1 instrument approach system comprised of two nondirectional low-power radio beacons: one located at the middle marker site 1 mile from the approach end of the runway and the other located at the outer marker site 4½ miles from the approach end of the runway.

(3) Ground control approach or talk-down system.

(4) VHF communications system between aircraft and ground.

(5) VHF radio ranges.

(6) Bartow high-intensity approach lights.

(7) Bartow high-intensity runway lights.

(8) Neon approach lights.

(9) Snow lights for runway definition.

(10) Standard runway contact lights.

All or a part of the above facilities are installed at Washington National Airport; Newark Army Air Base; La Guardia Airport; Mitchel Field, L.I.; Westover Field, Mass.; Grenier Field, Manchester, N.H.; Dow Field, Bangor, Me.; and Presque Isle, Me.

Reports

If you were an Air Transport Command pilot making an instrument flight over this airway using the above facilities, you would be asked to report on the following:

(1) Malfunctioning of any of the facilities.

(2) The necessity in your opinion for three 75-megacycle markers and their spacing as included in the Army Air Forces Instrument Approach System: the boundary, middle, and outer.

(3) Should an audio indication supplement the visual markers?

(4) The importance of combining *radio beacons* with the other facilities for use in the approved approach system.

(5) Whether you would like an observer at the middle marker site to give last-minute weather conditions on an approach.

(6) Would two automatic direction finders aid your flight?

(7) What navigational assistance will you expect from the two-course localizer?

To have been presented at the I.A.S. Thirteenth Annual Meeting which was canceled to cooperate with a Government appeal (January, 1945) to refrain from holding conventions and meetings.

* This article represents the author's personal views. It does not imply official A.A.F. comment.

† Lieutenant Colonel.

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Big Brother

Cargo counterpart of the famed B-29 is the tremendous new Boeing C-97, unveiled in a burst of glory when it recently made a record-shattering flight from Seattle to Washington, D. C., averaging 383 miles an hour. Whether carrying a full load in its 10,000 feet of cargo space or 100 fully-equipped troops, one thing is certain — the C-97 is in a class by itself when it comes to helping our Army "git thar fustest with the mostest."

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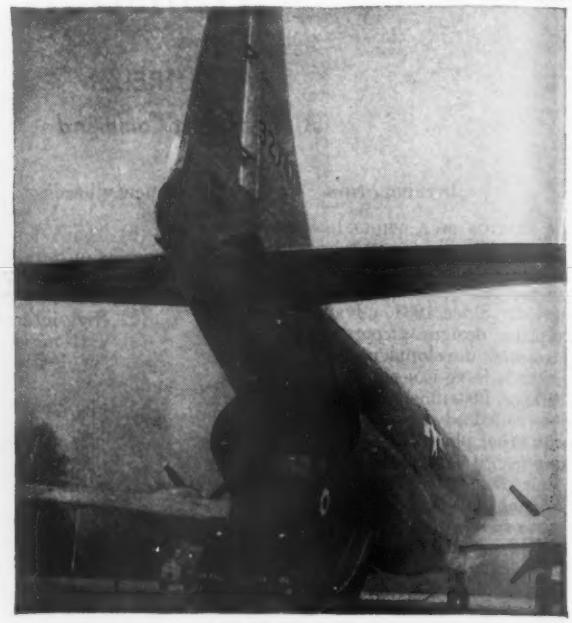

"Bite size" for the big plane is this 1½-ton truck, shown ascending the special ramp in the tail. Identical with the B-29 except for its huge double-decked fuselage, the C-97 can carry big trucks, light tanks, or 100 troops 2000 miles non-stop in less than 10 hours.

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(8) Whether you could make use of the back course of the localizer for an approach with or without a reverse sensing switch. Is a straight-in approach satisfactory under the existing wind conditions at each airport where an instrument approach is made?

(9) What is your opinion of the requirement for alternates on this flight?

(10) Do you consider both pressure altitude and altimeter settings by radio necessary before landing?

(11) Do you believe the glide path angle too steep? Does it safely clear all obstructions on each approach? To what minimum altitude do you believe it should be used on approach?

(12) Give your impressions of the approach lights, their utility and effectiveness during restricted visibility approaches.

(13) Your comments will be expected with regard to the effectiveness of windshield wipers and defrosters and instrumentation and lighting in the cockpit.

(14) If your minimums during any approach are less than 500 ft. and/or visibility less than 1 mile, describe the procedure and technique used for landing and the relative importance of all facilities used on the approach and landing.

(15) What are your recommendations for adding to, changing, improving, or deleting aids or equipment to enhance the safety and certainty of the operation over this airway?

Six Months' Operations

Pilots of the Navigation and Landing Aids Unit, Air Transport Command, for the past 6 months, have been flying all low-ceiling and restricted visibility conditions where ceilings have been less than 500 ft. and/or visibility less than 1 mile. During this period approximately 100 approaches have been made when ceilings were less than 200 ft. and/or visibility less than $^1/_2$ mile. While this number of landings has been attempted it does not mean that all types of weather and visibility conditions have been encountered.

It is important that conclusions relative to approach facilities be drawn from the cross-section opinion of a large group of pilots with broad experience. Today there are many conflicting opinions on the merits of facilities for all-weather flight, from radio beacons and glide paths to high-intensity approach lights. These opinions are sincere, but many have been formed from the limited experience of isolated weather flights.

On almost every instrument approach the particular weather condition encountered is different. This fact seems even more important in judging approach facilities when ceilings are less than 200 ft. or visibilities less than $^1/_2$ mile. Such factors as ceiling, wind, precipitation, visibility, darkness, turbulence, and static affect the technique used on an instrument approach under these lower limits. All of these conditions should be experienced by a pilot who gives a conclusive statement on the value of facilities used or an opinion regarding additional requirements.

A small group of pilots and observers of the Air Transport Command have witnessed this variety of different conditions during 6 months' operations. This experience is believed sufficient to justify some evaluation of the problems involved and, also, the attempt to arrive at some solutions for the immediate future.

Improved Traffic Control—A Major Requirement

The outstanding problem requiring both short- and long-range solution for all-weather transport operations is the control of traffic, particularly at congested terminals such as Washington, La Guardia, and Chicago. This problem is of such magnitude as to be a complete study in itself and is to be discussed separately by Capt. Sam Saint. Unless the handling of traffic can be expedited prior to, or concurrently with, the improvement of navigation and landing facilities, we will not have accomplished much of importance toward all-weather operation.

The second outstanding requirement for the operation of scheduled transport service in all types of weather is the improvement of approach lights and runway lights so that pilots landing during restricted visibility conditions can, by the aid of such lights, complete landings visually and not blind.

Blind landing of airplanes in transport operation is an expression that should be forgotten by our generation. There is too much loose talk on this subject. A rule should be made that anyone wishing to be heard on the subject of blind landing, should, either as pilot or observer, first make some approaches down to 200 ft. on instruments. The experience of approaching within 200 ft. of poles and wires and buildings without being able to see beyond the cockpit windows is extremely enlightening.

We might as well face the facts, roll up our sleeves, and get busy on the installation of the best approach and runway lights possible. This program should consider both day and night operation with restricted visibility.

Experience Reveals Need for Further Study of the Approach Light Problem

Numerous daylight landings and approaches have been made by pilots of the Navigation and Landings Unit under extremely low ceiling and visibility conditions. Observations during these approaches have accentuated certain limitations of the present neon bar and high-intensity approach lights. Several approaches made at Newark where ceiling was indefinite at approximately 200 ft. and visibility $^1/_4$ mile were outstanding in revealing the necessity for better approach lights. One row of approach lights became faintly distinguishable as mere pin points of light at approximately 250 ft. It required a moment's searching on both sides of this row to determine the location of the second row. Then, while progressing along the approach path, additional searching was required to define the starting point of the runway lights, even with the definite change from red to white and the green threshold lights between. A single row of approach lights leading to the center of the runway would have clarified both of the above problems.

It will obviously be necessary that such a line of approach lights be visible whether the airplane is on the direct approach path, above or below it, or off to either side. A flight not quite lined up with the runway is in more urgent need of approach lights than one already in the groove. The lights must be a more distinctive red in color, be closer spaced, and have flashing characteristics or other features to distinguish them instantly from other lights in the vicinity, either in daylight or darkness.

It appears that large fixtures of nondirected light closely spaced will be required for a distance of not less than 3,000 ft. on the approach to all instrument landing runways. For better night visibility conditions a large percentage of such fixtures would be turned off to prevent blinding. All would be used only in daylight or in extremely poor night conditions. A request has been submitted to make a trial installation of approach lights having the above features for service check.

The third most important facility required for all-weather transport operation is the two-course VHF visual beam or localizer of the Army Instrument Approach System. This localizer beam is the most important directional facility for use on an instrument approach and is a valuable aid for short-range navigation. Its reception is unaffected by atmospheric or precipitation static.

The range of this localizer beam is 120 miles for the two courses when flying at an altitude of 6,000 ft.—60 miles each for the front and back course. It is important that a careful check be made of the site for the installation of the localizer transmitter to ensure against reflections from hangars, power lines, or other objects that might cause bends in the course. A mobile unit should be carefully tested at a site selected before an installation is made.

For the immediate future these localizers should be installed at each airport of consequence along the airways throughout the United States and on the best instrument approach runways of such airports. Thus they will serve as part of the instrument approach system for that airport and, in addition, as a necessary navigation aid during those static conditions where communications, aural ranges, and automatic direction finders are rendered useless.

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For two reasons, relating to the immediate problems for improved weather operation, these instrument approach localizer installations should supersede further installation of the VHF ranges. First, the airplane receivers have but six channels; second, all available equipment, man power, and funds should be used to complete a nation-wide coverage of instrument approach facilities. The success and utilization of the instrument approach facilities will be in proportion to the number of such installations, a larger number providing more suitable alternates. This will certainly be true during the coming transitional period as we allow greater disregard for weather minimums in transport operations. Each localizer should have the normal aural two-letter station identification. The Newark identification, for example, should be NK.

The Value of ADF Locator Stations

The fourth requirement in progressing toward all-weather transport operation is the installation of two nondirectional, low-power radio beacons as a part of the instrument approach system, one located at the middle marker site approximately 3,800 ft. from the end of the instrument approach runway and the other located at the outer marker site $3\frac{1}{2}$ miles from the middle marker. Experience of Air Transport Command pilots to date has shown that the present 75-megacycle marker transmitters and receivers are not sufficiently reliable and require the double check furnished by the radio beacon homing stations for extremely low approaches.

Since this fourth requirement re-emphasizes the use of the radio beacons of the A-1 system and since the value of these stations in combination with the other facilities recommended has become a highly controversial issue, it is necessary to discuss this fourth requirement in more detail.

It cannot be denied that these facilities will fail under occasional conditions of severe static, and it must be admitted that the problem of finding enough frequencies for ground installations at all major airports is a difficult one. Outweighing these considerations, however, service test of the combination here recommended has shown sufficient need for the homing stations to justify the effort necessary to make frequencies available and to justify their use on the low-frequency bands until higher frequencies can be used.

The value of the homing stations to the overall combination can be simply outlined; whether in a holding pattern, entering the landing system from any direction, or maneuvering from a missed approach, pilot fatigue is minimized by the addition of the homing stations. This is true because navigation with the ADF alone does not require continuous concentration. The heading while approaching the homing station may vary continuously, and the pilot may still pass reasonably close over the station and know precisely when it is passed.

Beam bracketing, on the other hand, requires continuous concentration. First, a heading is chosen. This heading must be flown accurately for a period of time and the resultant signal change noted. By experienced analysis of this signal change, a new heading must be chosen and the resultant signal change again mentally cataloged. If the result is to have the desired accuracy, each successive heading flown must take into consideration the combined results of all previous headings.

In flying an ADF indication the pilot's concentration may be broken without serious results. In beam bracketing, however, whether of a visual indication or an oral signal, when the pilot's attention is drawn away momentarily so that the heading varies unintentionally, much of the bracketing process must be done over again to re-establish the course. Obviously, where navigation is accomplished by beam bracketing alone, the efficiency of the operation will vary widely with the experience and fatigue factor of the individual pilot.

The shortcomings of both techniques, however, are largely overcome by using both methods in combination. The localizer gives accurate course definition, and the ADF provides a direct association of the airplane's heading with known points on the course.

Service Tests

Service test has shown the following advantages for this combination:

(1) Proper alignment on the approach path can be accomplished in less distance than that required to establish the course by means of the localizer alone. This feature is of considerable value to traffic control and the laying out of economical traffic patterns. It is going to be difficult to provide straight-in approaches from several directions at an airport where the holding position is several miles away and the approach itself must be started from as many as 10 miles away.

(2) Necessary confirmation of passing over the 75-megacycle outer and inner markers is achieved. The outer beacon confirms the location along the approach path where let-down should begin. The middle beacon confirms the location along the approach path where final descent to the runway must be started if the landing is to be completed satisfactorily. Normally, the flight will have arrived at a safe minimum altitude prior to reaching this point and should have established visual contact if current minimums are used.

(3) When the approach is free of obstructions from the middle marker to the runway and the runway is long and the wind favorable, a second-stage descent to a lower minimum is entirely practical. This feature of the system recommended has been utilized by pilots of the Navigation and Landing Aids Unit to make numerous landings with ceilings in the neighborhood of 200 ft. and visibilities of $\frac{1}{4}$ mile or less.

(4) From the psychologic point of view it is most reassuring, upon reaching and holding a minimum safe altitude on instruments, to have the double check of the ADF reversal, in addition to the flashing of the marker light, before descending. These few seconds are the crux of the entire problem of restricted visibility landing. They should be free from confusion and indecision. After the ADF reverses and marker light flashes, the pilot can then descend to the final minimum with complete assurance. If, on reaching this absolute minimum altitude, the approach light pattern is distinct, he may complete the landing. If it is not, immediate pull-out is in order.

Glide Path and 75-Megacycle Markers Also Required

The fifth requirement for all-weather operation is the glide path. Regardless of the pilot technique used on an approach, the glide path will assist in establishing a satisfactory rate of descent. In many conditions where stable air prevails, the glide path can be flown to whatever safe minimum altitude is established. It will, in addition, double check the altitude at both the outer and middle markers. Precautions in training should stress over-control of longitudinal attitude near the minimum altitudes in attempting to keep the glide-path needle centered.

The 75-megacycle markers are the sixth requirement for instrument approach aids to facilitate all-weather flight. From actual weather operation, it appears that the boundary marker could be discontinued for a certain transitional period. This boundary marker often overlaps the middle-marker indication, particularly at higher altitudes or when receivers are sensitive.

With suitable approach lights extending 3,000 ft. from the end of the runway, it seems desirable that the present middle marker should be designated the inner marker. Both this middle marker and homing beacon would serve their purposes better if they were located 3,800 ft. from the end of the runway instead of a mile. This location appears desirable unless obstructions are such that a greater distance is required. Where runways are above average in length and obstructions not a hazard, this distance could be further reduced to 3,500 ft. The outer marker and outer homing beacon should, accordingly, be $3\frac{1}{2}$ miles from the inner marker and homing beacon.

The seventh requirement for safe landing during all-weather flight is the removal of obstructions on the approach to instrument landing runways and the prevention of future obstructions. Obstructions from the middle marker to

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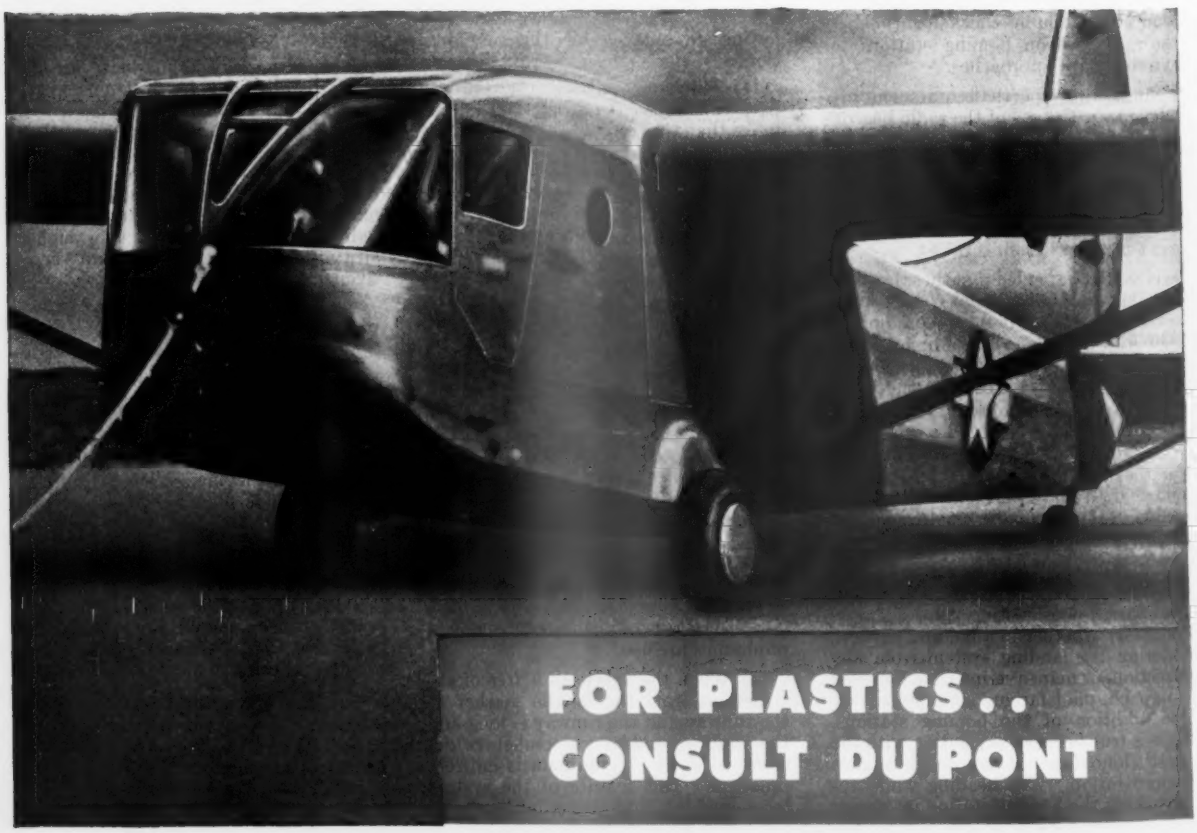

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the runway should not be higher than a ratio of 100 to 1. Actual hazards and mental hazards will be minimized by such a policy. Certainly no obstructions should endanger an airplane descending low over the approach lights for a landing.

The eighth requirement for landing during all weather operations is the adoption of an improved system for barometric altimeter setting. Towers and radio communications stations should furnish airplanes with both altimeter setting and pressure altitude setting. Altimeter setting means adjusting the airplane altimeter to sea-level correction. When so adjusted, the hands on a sensitive altimeter will indicate the airport elevation above sea level when landing.

Pressure altitude setting means adjusting the airplane altimeter to the height above the airport. When so adjusted, the hands on the sensitive altimeter will read zero when the airplane lands. The pressure altitude is obtained by the tower or radio operator reading the setting indicated by two triangular markers on the dial. The correct reading of these markers is obtained by setting the hands of the altimeter to the height of the instrument above the runway. Ten additional feet are subtracted, since an average airplane altimeter is 10 ft. above the runway after landing. This reading is transmitted to the airplane in feet, and the pilot makes an identical setting of the ship's altimeter. If an airplane altimeter reads zero upon landing, an additional calculation is eliminated from the flight crew's duties while making an instrument approach and landing.

Activating a Program for the Future

These eight requirements for all-weather transport operations could be effected within a reasonably short time and without further engineering or laboratory development. The ground facilities required are available or could be made available within the near future for installation over the principal domestic routes in the United States. The next step taken toward all-weather transport operation should be the installation of no less than 100 complete instrument approach systems. These installations should be distributed over the four principal transcontinental airways and the four principal north and south airways.

The immediate installation of instrument approach systems at each field as previously discussed should consist of these elements: (1) localizer beam transmitter; (2) 3,000 ft. of suitable approach lights; (3) one nondirectional radio beacon and 75-megacycle marker located 3,800 ft. from the approach end of the runway; and (4) a second nondirectional radio beacon and 75-megacycle marker located 3½ miles from the inner radio beacon and marker.

Concurrently with the installation of these five elements at some 100 airports throughout the United States, many of the other requirements for all-weather transport operation could be completed. Traffic and approach control procedures and regulations could be prepared along with the landing procedure for each airport.

A program could be well under way to remove all obstructions possible from the approaches to the instrument landing runways selected at each airport. Such a program should endeavor to clear the approach path completely to the end of the approach lights. A standard should be adopted to reduce the height of obstructions on the remainder of the approach to a 100 to 1 glide ratio as measured from the end of the runway.

A system for transmitting pressure altitude settings to aircraft should be set up at each airport.

The pilot's training program should include traffic-control and landing procedures. Emphasis should be placed on pull-out procedures, since recovery from a missed approach is more critical when descent is made to lower minimums.

It is the author's opinion, after several months of flying all-weather conditions on the northeast airway, that we have within our reach a possible solution to much of the all-weather operating problem. For the first time we actually have most of the equipment and facilities available to take a major step forward. With the proper facilities in operation at 100 or more fields along our airways, we may be able to disregard minimums as the controlling factor in air transport operation. All flights could be dispatched with two or more alternates—an alternate meaning an airport equipped with instrument approach facilities, within the fuel range of the flight, where ceiling and visibility were expected to remain above 200 ft. and ½ mile.

Weather Conditions as Affecting Cancellations

An analysis of past weather conditions will show that there are few days that would result in cancellation if operation were instituted on such a basis.

Meteorologists considered Christmas Day one of the worst visibility conditions of the year in the eastern part of the United States. A condition of this kind, of course, at the present, adversely affects the aviation war program in three ways:

(1) There were on this day three major crashes, one at Harrisburg, one at Indianapolis and one in Tennessee where pilots were caught by weather and attempted approaches for landing without adequate facilities. All resulted in heavy losses in property and lives.

(2) Nearly all other flying, both air line and military, was suspended for the day in the eastern half of the United States.

(3) In the minds of people requiring positive, rapid transportation and those planning tactical and military operations, the dependability of air transportation is rendered uncertain.

Table 1

Place	Ceiling, Ft.	Visibility, Miles
Newark	0	3/16
Mitchel Field	0	0
La Guardia Field	500	1
Philadelphia	600	3/4
Washington	500	1
Richmond	4,500	4
Westover Field	600	3/4
Manchester	500	1
Bangor	500	1
Presque Isle	700	2
Allentown	500	1/8
Pittsburgh	0	1/16
Harrisburg	600	1/2
Columbus	400	1 1/4
Indianapolis	700	1
St. Louis	700	4

Table 1 shows the weather sequences at 1330 on December 25, 1944, at a number of the principal fields in the eastern part of the United States.

With instrument approach facilities as herein recommended, transport operations could have been routine at this time, with the exceptions of Newark, Mitchel Field, Allentown, and Pittsburgh. Certainly there would have been little concern over the possibility of aircraft being caught in a condition where there were no suitable alternates. An analysis of many weather conditions has been made, and there has been no time when an overall operation could not be conducted based on two or more alternates having at least 200-ft. ceiling and ½-mile visibility.

Even in the local New York area there has not been a condition during the past 6 months of all-weather flying by pilots of the Navigation and Landing Aids Unit of the Air Transport Command when visual landings were impossible at one of the three fields—La Guardia, Mitchel, or Newark.

Conclusion

The program herein recommended may be just the beginning of the solution of aviation's biggest problem—all-weather operation—but this beginning may give us a clearer definition of the problem. It may bring us face to face with realistic requirements. It may show our airplane, airport, radio, accessory, and lighting engineers; our pilots; and operations people which roads lead to a final goal. It will, at the same time, increase the safety and efficiency of our transport operations.

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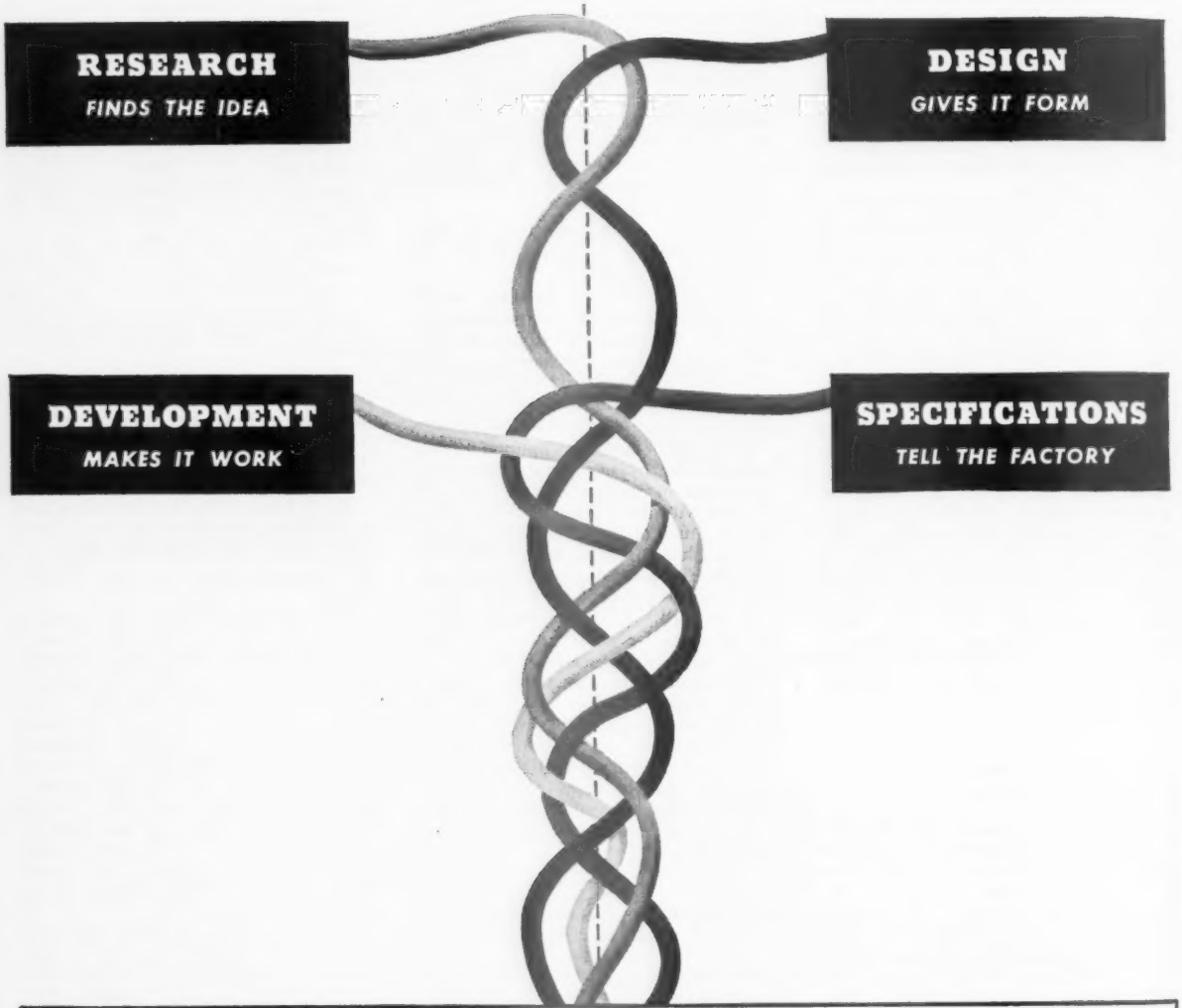

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Institute News

Gifts to the Aeronautical Archives

The Air Registration Board in London sent its *Register of Civil Aircraft*, through the courtesy of Sir Frederick Handley Page and T. R. Thomas. This register is on cards, and new cards are added monthly. The Smithsonian Institution gave a bronze replica of the Langley Medal awarded to Dr. Joseph S. Ames in 1935. The Society of Automotive Engineers gave a bronze replica of the Manly Memorial Medal, through the courtesy of John A. C. Warner.

A back file of the *Giornale dell' Aviatore*, published for the Italian Air Force by the Mediterranean Allied Air Forces, was received through the courtesy of Lt. Gen. Ira C. Eaker. The Glenn L. Martin-Nebraska Company gave its badges and insignia, and a file of its *Technograph* and pamphlets were received from The Glenn L. Martin Company in Baltimore.

Mrs. Bella C. Landauer sent a design, "Manhattan," by Ruth Reeves, on silk shantung, adding to her previous generous gifts. Albert A. Arnhym sent his book, *Comfortization of Aircraft*. H. Lionel Williams gave *The Photographic History of the Great European War in Gravure*. Jerome Lederer sent 113 house organs and 16 pamphlets, timetables, and company annual reports. A lapel pin of Adel Precision Products Corporation was received from Bennett H. Horchler.

A scrapbook of the aeronautical pioneer A. Leo Stevens, covering the years from 1908 to 1942, was presented by Mrs. A. Leo Stevens, adding to previous generous gifts. Maintenance and operating manuals and *The American Air Navigator*, by Charles Mattingly, were received from the Consolidated Vultee Aircraft Corporation through the courtesy of Welman A. Shrader.

James H. Drake presented the first edition of *Notes on Life and Letters*, by Joseph Conrad, London, 1921, containing his impressions of his first flight, made in a Royal Navy biplane. Lt. Col. A. L. Mieville of the British Ministry of Supply Mission gave his book, *Astronomical Navigation Without Mathematics*. The British Air Commission in Washington added 16 *British Air Ministry Translations* to the large number previously given.

Documents relating to applications before the Civil Aeronautics Board, for new air routes and extensions of existing routes, were received from Braniff Airways, Inc., Eastern Air Lines, Inc., Southwest Airways Company, Spartan Airlines, Inc., Transcontinental & Western Air, Inc., United Air Lines, Inc., and K. B. Van Zante.

The Air Technical Service Command at Wright Field sent three bibliographies of Russian material on cold-weather operation, parachutes, and gliders and 18 translations from the Russian on these subjects. The Fairchild Engine & Airplane Corporation gave its *Feederline Transport Market Survey*, through the courtesy of Dean C. Smith. The Aeronautical Chamber of Commerce of America gave its *International Standardization Report* of the United States Aeronautical Standards Mission to Great Britain.

Additional gifts were received from the Aeronautical Digest Publishing Company; Air Industries and Transport Association of Canada; Camloc Fastener Corporation; Chamber of Commerce of the United States of America; Civil Air Patrol League; Connecticut State Department of Education; Douglas Aircraft Company, Inc.; Fairchild Engine & Airplane Corporation; General Electric Company; General Federation of Women's Clubs; Indiana Economic Council; Mr. and Mrs. Walter Isard; Jacksonville, Florida, Chamber of Commerce; New England Council; A.A.F., Ellington Field, Tex.; Air Technical Service Command; Forest Products Laboratory; and U.S. Department of State.

New Corporate Member

Carrier Corporation, Syracuse, N.Y., has recently become a Corporate Member of the Institute.

Air conditioning and refrigeration, principal products of Carrier Corporation, serve aviation in a wide variety of ways. For example, air conditioning is utilized in plants manufacturing precision parts for airplanes to ensure greater precision and to protect highly polished surfaces from dust, dirt, and the corrosive effects of perspiration. It serves a like purpose in the manufacture of altimeters, bombsights, gages, and other precision mechanisms found in airplanes. Test rooms for radio and other instruments are equipped with air conditioning and refrigeration to simulate conditions under which equipment may operate in actual flight. Carrier equipment plays an important part in wind tunnels, such as the one built by the National Advisory Committee for Aeronautics at Cleveland.

The corporation has designed and built special portable coolers that make possible the efficient servicing of plant interiors even in the hottest climates. In airport control towers, efficient working conditions are maintained by the use of air conditioning. Carrier centrifugal compressors are used in the petroleum industry for manufacturing high-test gasoline. The corporation supplies equipment that aids in the production and storage of airplane tires; it has an active part both in the processing and manufacturing of textiles used in airplanes; and air conditioning serves an important role in the preservation of flying suits and parachutes.

In addition to its engineering skill in the fields of air conditioning and refrigeration, it has developed extensive knowledge in fields of heat transfer, acoustics, fluid flow, thermodynamics, and other fields technically associated with its main interest.

Sections and Branches

Buffalo Section

The sixth meeting of the 1944–1945 program of the Buffalo Section was a technical meeting held February 13 at the Park Lane Restaurant. Following dinner and the registration of local members and guests, Chairman Hawkins announced the approval and acceptance of the constitution for the Section. James S. Limage, of the Bell Aircraft Corporation, introduced Carl Friedlander, Vice-President of Aeronca Aircraft Corporation, who gave a brief history of his company as a prelude to a review of its current activities. He told of the wartime services of Aeronca airplanes and mentioned the progress being made in the light-airplane field, which he stated would be incorporated in postwar designs. Pictures of current and future airplanes were exhibited during and after the talk.

The second speaker was Frederic Flader, President of the F. Flader Company, who was introduced by the Chairman. Based on a recent trip that he made to China, Mr. Flader contrasted methods used in China and those employed in the United States, with reference to the saving of man power and time by the use of power and mecha-

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"Effects of Low-Temperature Heat-Treatment on Elastic Properties of Cold-Rolled Austenitic Stainless Steels" — a 16-page paper, illustrated by charts and graphs, on the results of various low-temperature heat-treatments on the mechanical properties of cold-rolled austenitic stainless steels.

"High-Manganese Austenitic Steels" — physical data on new high-strength steel, for possible use in aircraft construction and in other lightweight structures.

"Tension and Compression Stress-Strain Characteristics of Cold-Rolled Austenitic Chromium-Nickel and Chromium-Manganese-Nickel Stainless Steels" — a compilation of important physical data on austenitic chromium-nickel and chromium-manganese-nickel steels.

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nized equipment. He outlined his views on desirable postwar economic conditions, accentuating the desirability of the ultimate goal of large production at minimum costs. Sixty-nine members and guests were present at the dinner and a total of 85 attended the meeting.

Seattle Section

A dinner meeting of the Seattle Section was held on February 28, with 411 local members and guests in attendance. The entire meeting was devoted to "The Record Cross-Country Flight of the Boeing Stratocruiser," which was discussed by four members of the crew.

A. E. Merill, Pilot of the airplane, discussed the general features of the airplane and the flight. J. B. Fornasero, Copilot, talked about navigation and the use of radio aids as applied to such a long-distance, nonstop flight at high altitude and high speed.

K. J. Luplow, Flight Engineer, discussed the duties of the Flight Engineer in large airplanes. A. F. Kelsey, who served as Project Engineer, talked about the various loading possibilities of the airplane as a military cargo carrier.

Washington, D.C., Section

A new Section has been organized at Washington, D.C. At the initial meeting held on April 3 at the United States Chamber of Commerce Building the following officers were elected: Chairman, Dr. F. W. Reichelderfer; Vice-Chairman, Lt. Comdr. J. R. Hoyt; Secretary, E. W. Norris; Treasurer, R. F. Broberg. The Advisory Committee is as follows: J. H. Geisse, Major Gen. David N. W. Grant, Dr. G. W. Lewis, E. P. Warner, and F. E. Weick.

Dr. Ludwig G. Lederer, of Pennsylvania-Central Airlines, discussed certain aspects of aviation medicine. The address was similar to that which Dr. Lederer gave at a meeting of the New York Section earlier this year. Approximately 70 local members and guests attended, including Charles H. Colvin, President of the Institute, and Robert R. Dexter, Secretary of the Institute.

Wichita Section

A joint meeting of the Wichita Section with the local branch of the Society of Automotive Engineers was held on March 13. No business was transacted, the entire session being devoted to a talk by William B. Stout, Director of Research of the Stout Research Division of Consolidated Vultee Aircraft Corporation. Mr. Stout spoke on the topic "Imagineering," the theme being the great progress that has been made and will be made in the engineering field. He mentioned several specific developments and outlined how various technical advances would have an important effect upon life in the future. The attendance at the meeting was approximately 1,200 local members and guests of both organizations.

University of Colorado

A new Branch of the Institute was inaugurated in the latter part of February at the University of Colorado, at Boulder. Professor K. D. Wood, formerly of Purdue University, is the Faculty Adviser at the University of Colorado Branch. The new Branch has 42 members.

University of Detroit

The January meeting was a combined technical and business session held on January 4 with an attendance of 24 members. The film *Man's Conquest of the Air* was shown.

On March 21 the University of Detroit Branch joined with other branches of engineering societies and with the Alumni Association for a joint meeting called the "Slide-Rule Dinner." It was the thirteenth such annual dinner meeting and was held at the Detroit Yacht Club. An extensive program was conducted, including the presentation of awards by Pi Eta Chapter of Pi Tau Sigma and of the Michigan Delta Chapter of Tau Beta Pi. The Toastmaster was Robert H. Thomas and the speakers were Rev. William J. Millor, President of the University of Detroit, who gave the address of welcome; Dean Clement J. Freund, of the College of Engineering of the University of Detroit; and Andrew Kucher, Director of Research with the Bendix Aviation Corporation. Mr. Kucher presented the paper on "Engineering Education."

The Guests of Honor included representatives of the Faculty of the University and executives of industrial plants in the vicinity of Detroit, and municipal leaders.

Georgia School of Technology

Officers were elected at the business meeting of the Georgia Tech Branch on March 23. The new officers are as follows: Chairman, C. R. Dutton; Vice-Chairman, C. B. Cliett; Secretary-Treasurer, D. A. Holladay. Navy films recording battles in the South Pacific were shown.

Illinois Institute of Technology

A business meeting of the Illinois Institute of Technology Branch was held on March 23 at which the following new officers were elected: Chairman, Sidney Mayster; Vice-Chairman, Albert Spooner; Secretary, David Meyers; Treasurer, Edward Goetsch. The films *Harris Hill* and *Silent Wings*, both about gliding and soaring, were shown.

Casey Jones School of Aeronautics

On March 9 a business meeting was held at which it was voted to increase the Branch dues to $0.50 a month. Robert Rawding and Frank Tedesco were appointed as the new Co-Editors of the Branch's paper *Contact*.

University of Kansas

At a combined technical and business meeting the following new officers were elected: Chairman, Nelson May; Vice-Chairman, Eugene Arnold; Secretary-Treasurer, Lynn Leigh. Professor McCloy gave a talk about "Jet Propulsion."

On March 29 a technical meeting was addressed by Professor Hay on the subject of "Soaring and Gliding."

Louisiana State University

A meeting of Louisiana State University Branch was held on January 9. E. E. Maser spoke on "Jet Propulsion."

A business meeting was held on February 6 at which plans were completed for a social gathering. On March 16 a meeting was held at which three new members were elected.

Massachusetts Institute of Technology

At a technical meeting on March 26, Lt. Col. Jay Zeamer of the U.S. Army Air Forces gave a talk about the early phases of the war in the Pacific. Approximately 200 Student Members and their guests attended the meeting.

New York University

The meeting on February 6 was a technical meeting. Albert Sherman, of the Phaler Manufacturing Company, gave a talk about jet propulsion. At a technical meeting on February 20 a film made by The Pennsylvania State College titled *Construction of a Light Airplane*, giving details about the building of the Piper Cub, was shown. The film was obtained from the New York University Film Library.

On March 3 a joint meeting was held with the N.Y.U. branch of the American Society of Mechanical Engineers. Professor Frederick K. Teichmann, Chairman of the Department of Aeronautical Engineering at the University, spoke about the "Technical and Physiological Problems of Airplane Design."

University of Oklahoma

Three new members were elected at a meeting on March 12 in the Engineering Auditorium. Two films were shown: *Railroading* and *Aircraft Hydraulic Systems*.

Purdue University

A "Bell Aircraft" meeting was held by the Purdue University Branch on February 6 with 220 Student Members and guests in attendance. George Gillespie, a V-12 Senior, gave a short sketch of the history of Bell Aircraft Corporation. Charles Fay, Head of the Bell Aircraft Flight Test Section, spoke about the helicopter and the jet-propelled aircraft. Two films on the subjects were shown: *Bell Helicopter* and *Bell Jet Plane*. On February 27, a

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short business meeting was held at which the following officers were elected: Chairman, Donald H. Heile; Vice-Chairman, Robert M. Gray; Secretary-Treasurer, John E. Hove.

Rensselaer Polytechnic Institute

At a meeting on January 5 the films *Plexiglas* and *Boots Nuts* were shown. The meeting on February 2 had as guest speaker Dr. Burt L. Newkirk, of the Aeronautical Department of Rensselaer Polytechnic Institute. He gave a demonstration lecture about the gyroscope and its applications.

On March 9 the guest speaker was A. I. Sibila, of the Chance Vought Division of United Aircraft Corporation, who spoke about the problems encountered in the design of high-speed fighter airplanes. Officers were elected at a meeting on March 23 as follows: Chairman, H. M. De Groff; Treasurer, W. Z. Meyers; Secretary, M. T. Kehoe; Faculty Advisor, A. J. Fairbanks. The motion picture *Flight Characteristics of the P-38* was shown.

Spartan College of Aeronautical Engineering

At a business meeting on February 28 plans were discussed for obtaining speakers from industrial organizations to address future meetings of the Branch, and application cards were issued to new engineering students.

The meeting on March 13 was a combined technical and business session. The question of accepting meteorology students of the College as members of the Branch was discussed. The films *All Work and No Play*, *The Flying Fortress*, and *The P-38* were exhibited.

University of Texas

At the March 7 meeting of the University of Texas Branch the following officers were elected: Chairman, Ralph Merrill; Vice-Chairman, Barney Chaudoin; Corresponding Secretary, Merle Mueller; Recording Secretary, Danny Hearn; Treasurer, Elaine Marek.

At a technical meeting on March 23 the films *Wings Over Leyte* and *Two Miracles* were shown.

University of Wichita

A new Student Branch has been organized at the University of Wichita, with 14 members initially enrolled. The officers are as follows: Chairman, Melvin E. Smith; Vice-Chairman, Carl H. Prewitt; Secretary-Treasurer, James McClelland, Jr.; Faculty Adviser, Prof. Kenneth Razak.

News of Members

Cecil W. Armstrong has organized his own company under the name of Armstrong Plastics Company.

Albert Bree has joined Gould Aeronautical Division of Pratt, Read & Company, Inc.

Philip N. Bright has been appointed Chief of Structures of Aeronca Aircraft Corporation.

Kenneth Campbell, Senior Project Engineer of Wright Aeronautical Corporation, received the 1945 award of the Wright Brothers medal of the Society of Automotive Engineers, Inc. It is awarded for the best paper on aerodynamics delivered before an S.A.E. meeting, and the 1945 award was given for his treatise titled "Engine Cooling Fan Theory and Practice."

Thomas F. Carroll, Jr., has joined the Flight Test Section of the Allison Division of General Motors Corporation.

Edward G. Crofut is one of the organizers of Aerolab Development Company.

Edgar G. Dailey is now engineering Consultant to H. A. Lingard & Associates.

Ralph S. Damon, Vice-President and General Manager of American Airlines, Inc., and **Jack Frye,** President of Transcontinental & Western Air, Inc., are members of a special committee appointed by the War Production Board to engage in formulating a program of requirements for new aircraft.

Lloyd R. Gant is now Design and Liaison Engineer with Universal Moulded Products Corporation.

Brewster A. Gillies, formerly Assistant to the President of Ryan Aeronautical Company and Director of Flight Service, has been elected a Vice-President of the Company.

Paul E. Gravelle has received his commission as a Lieutenant in the U.S. Army Air Forces.

Alan H. Green has joined Edo Aircraft Corporation as an Aerodynamicist.

Donald W. Haarman has returned from military service as an officer in the Army Air Forces and has joined Kearfott Engineering Company.

Robert A. Hill has been appointed Maintenance Engineer with Mid-Continent Airlines.

Milton D. Hunnex is currently employed jointly by the San Bernardino Air Technical Service Command and the San Bernardino Valley Junior College as an Instructor.

David U. Hunter has become connected with the Elliott Company as a Research Engineer.

Raymond P. Lansing, Vice-President and Group Executive of Bendix Aviation Corporation and a member of its Administration and Engineering Policy committees, has been elected a member of the Board of Directors of the Corporation.

Benjamin M. Lent-Koop has entered the employ of North American Aviation, Inc., as a Layout Draftsman.

Dwight C. Maier has been appointed Works Manager of the Stout Research Division of Consolidated Vultee Aircraft Corporation.

Glenn L. Martin, President of The Glenn L. Martin Company, has been elected to the additional office of Chairman of the Board of Directors of The Glenn L. Martin-Nebraska Company, a subsidiary.

Philip T. Nickson is now a Project Stress Engineer with Edo Aircraft Corporation.

Michael M. Powers has been transferred to the post of Patents Engineer with Curtiss-Wright Corporation.

Raymond R. Pritchard has become connected with Bell Aircraft Corporation as a Layout Draftsman.

Ernest R. Reff has joined the Stinson Division of Consolidated Vultee Aircraft Corporation as a Structures Design Engineer.

John D. Rogers is now a Research Engineer with the California Research Corporation of Standard Oil Company of California.

William Selikoff has been appointed a Project Coordinator, Outside Production, with Ryan Aeronautical Company.

Walter A. Semion, formerly Project Engineer with Higgins Aircraft Inc., has been appointed to the office of Chief Engineer of D. J. Derry & Company.

David R. Shoults has been elected Vice-President of Sales of Bell Aircraft Corporation.

Ira Shur has entered the service of B. F. Hirsch, Inc., as a Design Engineer.

Jesse J. Steinman has joined the staff of Peter Altman, Engineering Consultant, as Chief of Structures.

Cyril W. Terry has been named to the position of Chief of the Flight Research Section of Ryan Aeronautical Company.

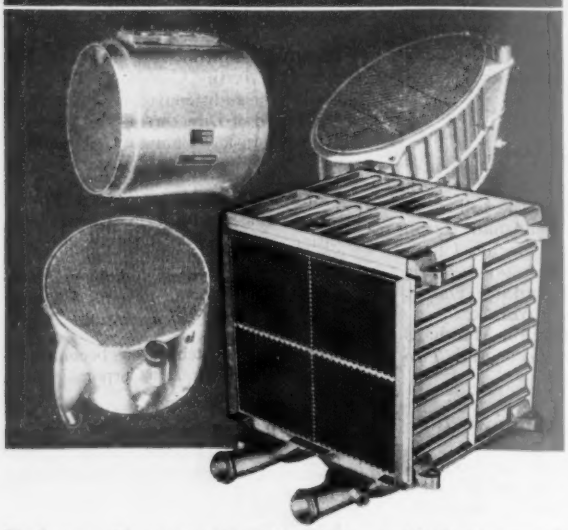
Milton J. Thompson, on leave as Head of the Aeronautical Department of the University of Texas, is currently engaged as Senior Engineer at Johns Hopkins Applied Physics Laboratory.

Arthur N. Tifford is now a Section Engineer in the Aviation Gas Turbine Division of Westinghouse Electric & Manufacturing Company.

Narcyz M. Wasilkowski has joined the Cleveland aircraft plant of the Fisher Body Division of General Motors Corporation as a Stress Engineer.

The following members of the Institute have been commissioned as Ensigns in the U.S. Navy: **Charles Brogger, James E. Davis, Roald N. Evensen, Wilfrid A. Fierle, John H. Kouns, Charles F. McDonough,** and **Garrett D. Paggon.**

ALUMINUM BRAZING LENGTHENS LIFE OF HEAT EXCHANGERS



Designers of heat transfer units are now achieving increased strength . . . not only *without* added structural reinforcements but also *with* a ⅔ weight reduction . . . by replacing copper and soft solder with aluminum and high temperature aluminum alloy bonding material.

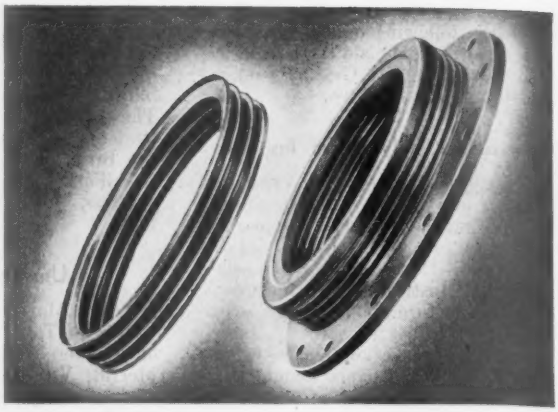
Clifford's notable discovery of the method of brazing aluminum in thin sections has resulted in the strengthening of heat transfer units three ways:

1. Heat treatable aluminum tubes resist working temperatures up to 275°, at which point copper tubes gradually anneal and break down.
2. Heat treatable aluminum alloy header plates, shells and other parts survive temperatures and pressures far above the safe limits of other metals commonly used in heat transfer units.
3. High temperature aluminum alloy bonding material withstands temperatures, pressures and strains several times higher than soft solder.

Those are the plusses USAAF designers obtained for several types of aircraft when Clifford Feather-Weight Oil Coolers and Coolant Radiators saved ⅔ the weight of the copper units they replaced.

ALUMINUM BRAZING'S FUTURE

Clifford's production is still 100% in war work. However, postwar applications of all-aluminum heat transfer units to automotive, heating, cooling and ventilating fields are being considered on the basis of suggestions and inquiries already received. Yours will be welcomed. *Clifford Feather-Weights save ⅔ the weight . . . same size and shape.* Clifford Manufacturing Co., 560 E. First Street, Boston 27, Massachusetts.



HOW HYDRAULICALLY-FORMED BELLOWS IMPROVE SHAFT SEAL PERFORMANCE

Shaft seals must be engineered to each application because conditions are seldom the same: the nature of the gas or liquid to be sealed; the pressure which the seal must oppose; the shaft diameter; its speed in r.p.m.; the space the seal will occupy; working temperatures.

Also in the design of such seals, problems like these must be solved:

The *seal nose* must be properly proportioned to prevent distortion during facing and during exposure to high service temperatures.

The *bearing material* must be scientifically correct for the specific operating conditions.

The *thrust spring* must exert proper thrust at its working length — parallel to the axis.

And even when these components are *right*, the seal will not provide a pressure-tight running seal against the rotating shaft shoulder *unless* the bellows has *sufficient strength* to stand the pressures involved and has the required flexibility.

That's where hydraulically-formed metallic bellows seals are superior to non-metallic and other metallic seals. Clifford — first to produce hydraulically-formed metallic bellows for industry — incorporates in shafts seals Hydron bellows with uniform wall thickness and accurately controlled metallurgical grain structure and physical properties. That's why Clifford has successfully solved some of America's most difficult shaft seal problems and why it will pay you to submit your seal problems to them for their recommendations. *First with the Facts on Hydraulically-Formed Bellows.* Clifford Manufacturing Company, 560 E. First Street, Boston 27, Massachusetts.

CLIFFORD *Feather Weight* **OIL COOLERS AND COOLANT RADIATORS**

HYDRAULICALLY-FORMED BELLOWS HYDRON

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted to membership in the grades indicated since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Hall, Archibald Maclay, M.E.; Div. Manager, Miami Div., Consolidated Vultee Aircraft Corp.

Kennedy, William D., Vice-President and Manager, Cincinnati Plant, Wright Aeronautical Corp., Curtiss-Wright Corp.

Loring, Samuel J., B.S.; Research Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Maloy, Raymond Baird, B.S. in Ae.E.; Technical Asst. to Director of Safety Regulation, Civil Aeronautical Administration.

Mathes, John Charles, B.S. in C.E.; Development Engineer, Magnesium Div., The Dow Chemical Co.

Elected to MEMBER Grade

Carey, Robert Henderson, M.S. in Engineering Mechanics; Research Engineer, Bakelite Corp.

Carroll, Charles Burr, B.S. in M.E.; Chief Project Engineer, Consolidated Vultee Aircraft Corp.

Clark, Louis Phillip, M.S. in Physics; Physicist, Naval Air Experimental Station, Navy Yard (Philadelphia).

Code, Ernest Balfour, B.S. in Ae.E.; Engineering Test Pilot, Boeing Aircraft Co.

Davis, Harold William, B.S. in Ae.E.; Chief Development Engineer, Atlantic Diesel Corp.

de Ferranti, Marc, Asst. Chief, Aerodynamics Dept., Research Lab., Curtiss-Wright Corp.

Ghatage, Vishnu Madhav, Ph.D.; Asst. Prof. of Aeronautics, Indian Institute of Science (India).

Guyton, Boone Tarlton, A.B.; Asst. Chief of Flight Test, Chance Vought Aircraft Div., United Aircraft Corp.

Hanna, Clinton Richards, B.S. in E.E.; Associate Director, Research Lab., Westinghouse Electric & Manufacturing Co.

Holman, Edward Henry, British Representative, British Air Commission (Washington, D.C.).

Hulbert, John Keightley, B.S. in Ae.E.; Aerodynamics Research Engineer, Research Lab., Curtiss-Wright Corp.

Magruder, Peyton Marshall, Director of Commercial Aircraft Sales, The Glenn L. Martin Co.

McGinness, James Wesley, Performance-Aerodynamics Group Leader, Canadair Ltd. (Canada).

Merrill, Albert Elliott, B.S. in E.E.; Project Engineering Flight Test Pilot, Boeing Aircraft Co.

Michel, Leopold Robert, M.S. in M.E.; Development Engineer, Polaroid Corp.

Milliken, Charles Smyth, M.S. in E.E.; Engineering Designer "B," Lockheed Aircraft Corp.

Ridley, Kenneth Felton, M.E. in Ae.E.; Chief Engineer, Hughes Aircraft Co.

Simpson, William McCray, Ph.D.; Prof. and Chairman, University of Kansas.

Thompson, Lee Price, Ph.D.; Supervisor, Technical Data Dept., AiResearch Manufacturing Co.

Vanik, Milford Frank, B.S. in Ae.E.; Chief, Aircraft Engineering Branch, C.A.A.

Wittner, Howard Maxwell, M.S. in Ae.E.; Asst. Chief Research Engineer, Republic Aviation Corp.

Transferred to MEMBER Grade

Bates, Francis, Jr., A.B. in Civil Engineering, Group Engineer and Weight Engineer, Lockheed Aircraft Corp.

Bradley, Francis Xavier, Jr., Major, Asst. Chief of Staff, Operations, Central African Div., U.S. Army Air Forces.

Hall, Dudley O., Sr. Project Engineer, Northwest Airlines, Inc.

Harris, Waldo, Lt., Asst. Wing Engineering Officer, U.S. Marine Corps.

Thrall, Edward Wolff, Jr., B.S. in M.E.; Structures Engineer A., Douglas Aircraft Co., Inc.

Whitelaw, Robert Leslie, B.Sc. Applied Hydromechanics; Sr. Project Engineer, Turbo-Research Ltd. (Canada).

Williams, Richard deHart, M.E. in Ae.E.; President, Accessories Manufacturing & Engineering Co.

Elected to Industrial Member Grade

Fuller, William Gardiner, Factory Manager, Globe Aircraft Corp.

Elected to Technical Member Grade

Biesemeyer, Kermit Theodore, Chief of Service School Laboratories, Allison Div., General Motors Corp.

Bode, George Myron, B.S. in Ae.E.; Experimental Engineer, Engineering & Research Corp.

Bollech, Thomas Vern, B.S. in Ae.E.; Aeronautical Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Broome, Joseph Wesley, B.S. in E.E.; Engineer, Electrical Design Section, A & M Engineering Div., General Electric Co.

Cole, Julian David, B.M.E.; Guggenheim Aeronautical Lab., California Institute of Technology.

Curzon, Alan John, Precision Inspector, Experimental Dept., Rolls-Royce Co. Ltd. (England).

de Carteret, Norman Weston Squares, B.Ae.E.; Ensign, U.S.N.R.

Forbes, Lawrence Russell, B.S. in M.E.; Engineering (Maintenance Officer), U.S. Army Air Forces.

Freche, John Charles, B.S. in Petroleum Engineering; Mechanical Engineer, Aircraft Engine Research Lab., N.A.C.A.

Lew, Fong Nye, B.Ae.E.; Stress Analyst, Consolidated Vultee Aircraft Corp.

Lewis, Neilson Wilde, B.S. in Bldg.; Engineer, Engineering & Research Corp.

Moon, George Leo, B.S. in E.E.; Jr. Development Engineer, Goodyear Aircraft Corp.

Platt, John Dee, B.A. in Chemistry; Sr. Development Engineer, Goodyear Aircraft Corp.

Sadler, Harold M., B.S. in M.E.; Aeronautical Engineer, Gazda Engineering.

Shannon, Edward Madison, B.S. in Ae.E.; Lt., U.S.N.R.

Transferred from Student to Technical Member

Connair, Sylvan Edward, Jr., B.Ae.E.; U.S. Navy.

Corrsin, Stanley, M.S. in Ae.E.; Research Asst., California Institute of Technology.

Fries, Gordon H., B.S.; Aerodynamics Engineer, Kellett Aircraft Corp.

Lin, Chia-Chiao, Ph.D.; Research Engineer, California Institute of Technology.

Linker, John Joseph, B.S. in Ae.E.; Experimental Test Engineer, Pratt & Whitney Aircraft Div., United Aircraft Corp.

McMurray, John Wightman, Jr., B.S. in Ae.E.; U.S. Navy.

Elected to Affiliate Grade

Gach, Martin, B.A.; Airway Traffic Controller, C.A.A.

Stenger, Carrol George, Production Supt. & Asst. to Development Engineer, Langley Corp.

Tarricone, Michael, Pvt., U.S. Army Air Forces.

VanDyke, Martin Montgomery, Industrial Engineer, Langley Corp.

Wagner, Richard E., SoM 3/C, U.S. Navy.

Necrology

Vincent Bendix

Vincent Bendix, an Industrial Member of the Institute and President of Bendix Helicopters, Inc., died suddenly on March 27 at his home in New York from the effects of a coronary thrombosis.

Mr. Bendix was born in Moline, Ill., on August 12, 1882. He was largely self-educated in law, commerce, and mechanical engineering, starting his business career at the age of 16 in railway work. Being greatly interested in the automobile and other mechanical devices, he experimented for several years with electric self-starters and improved brakes, and in 1937 he organized the Bendix Corporation and the Bendix Brake Company, of which he was President and Manager. The company manufactured brakes and starters for automobiles and airplanes and later was expanded into the organiza-

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tion now known as Bendix Aviation Corporation. He served as President and Chairman of the Executive Committee with that corporation until 1942. He had also been President and Director of Bendix-Westinghouse Automatic Air Brake Company and Chairman of the Board of Automatic Products Company and had served in an executive capacity with other corporations. He received numerous honorary awards, including the French Legion of Honor, and the rank of Knight Commander of the Order of the North Star presented by the King of Sweden. He had been a member of the Advisory Board of the Institute from 1936 to 1943, a Trustee of the Armour Institute of Technology, a Director of the National Association of Manufacturers, and member of many scientific, business, and social organizations. He was the donor of the Bendix Trophy, awarded for annual transcontinental air races.

In June, 1944, he formed Bendix Helicopters, Inc., to develop a personal type of helicopter, the designs of which had been completed and plans made for its quantity production after the cessation of hostilities.

Alfred Victor De Forest

Alfred Victor De Forest, a Fellow of the Institute, President of the Magnaflux Corporation and Professor of Mechanical Engineering at the Massachusetts Institute of Technology, died at the age of 56 on April 5 at his home in Marlboro, N.H. He was widely known for his development of the Magnaflux method of inspection of metals, in addition to his extensive work in engineering research and education.

Professor De Forest was born April 7, 1888, in New York and was graduated from the Massachusetts Institute of Technology in 1911. From 1912 to 1938 he was an instructor at Princeton University and was engaged in engineering work with the Remington Arms-Union Metallic Cartridge Company, the American Chain Company, Spang Chalfant and Company, the Wyckoff Drawn Steel Company, John Chatillon and Sons, Hamilton Standard Propellers Company, and other companies. He was the inventor not only of magnetic testing methods but of various methods of fatigue testing of springs and wires, of a magnetic strain gage, of an isothermal electromagnetic method of measuring wall thickness, and of numerous other processes.

In 1938 Professor De Forest was the recipient of the Sylvanus Albert Reed Award of the Institute. He was chosen for the award because of his development of the magnetic method of testing metals, particularly in its application in tests of airplane construction. He had received many other honorary awards for engineering achievements and was a member of numerous other scientific societies. He was the author of various papers about magnetic inspection and testing.

I. A. S.

Special Meetings Schedule

1945

August 16–17, 1945
LOS ANGELES MEETING

October 4–5, 1945
DETROIT MEETING

October 26, 1945
WASHINGTON MEETING

November 16, 1945
DAYTON MEETING

December 17, 1945
WRIGHT BROTHERS LECTURE, Washington, D.C.

The Officers and Council of the Institute invite participation in the Technical Sessions of the Meetings of the Institute.

The Meetings Committee will consider for inclusion on the program complete papers, or outlines or summaries of proposed papers.

Information for Participants

(1) Complete papers, or outlines or summaries should be submitted in triplicate at least four months prior to the meeting at which it is proposed to present the paper. Outlines or summaries should not exceed 1,000 words.

(2) Each paper should be so planned that it may be presented within a time limit of 45 minutes.

(3) All papers submitted will be considered for publication in the **Journal of the Aeronautical Sciences** or the **Aeronautical Engineering Review.** While a paper should be planned to take only 45 minutes for presentation at a meeting, the written presentation may have a maximum length of approximately 15,000 words.

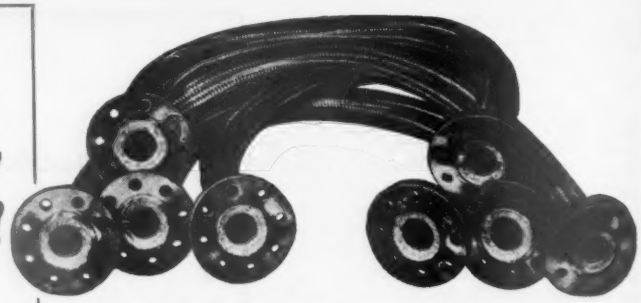
(4) All material received will be submitted to the Meetings Committee. Authors will be notified, in ample time to prepare the complete paper, whether or not their papers can be scheduled for presentation.

All correspondence should be addressed to

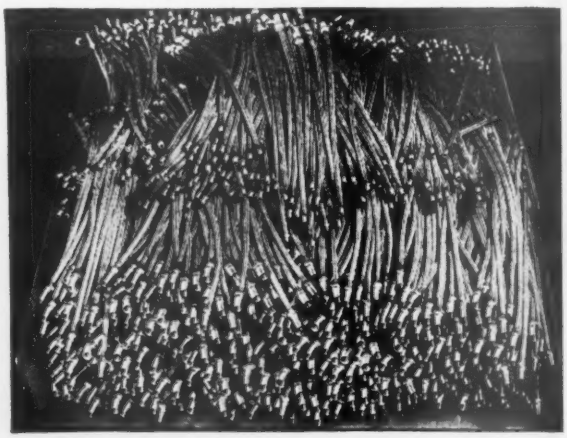
The Meetings Committee
Institute of the Aeronautical Sciences
1505 RCA Building West
30 Rockefeller Plaza
New York 20, N. Y.

Do You Build Bulldozers, Locomotives or PT Boats?

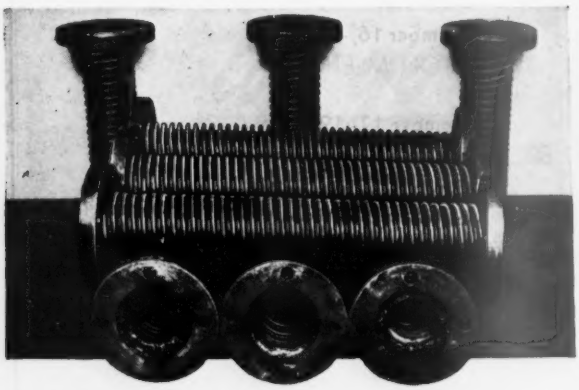
THESE TYPICAL APPLICATIONS MAY SUGGEST WHERE YOU, TOO, CAN PROFITABLY EMPLOY FLEXIBLE METAL HOSE AND TUBING



AIR STARTING LINES for locomotive diesels, involving pressures of 250 p.s.i., made of 2" I.D. bronze seamless tubing with bronze braid. Heavy duty steel flanges are Tobin Bronze welded.



HIGH-PRESSURE GREASE LINES for lubricating clutch release bearings on bulldozers and tractors, made of 3/16" I.D. TYPE M.P. steel hose, steel braid covered. Brass fittings are soldered on.

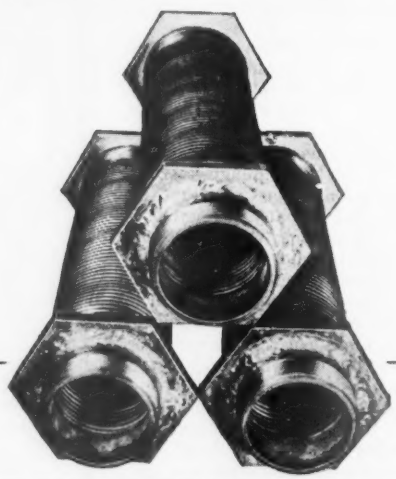


DIESEL EXHAUSTS absorb vibration, compensate for expansion and contraction. Made of 4" I.D. corrugated steel hose with welded flanges.

GAS, steam, liquid air, or grease connections which are constantly subjected to movement or vibration can cause endless grief. To make sure of top performance right from the start, use American Flexible Metal Hose or Seamless Flexible Tubing for all such connections.

"American," available in a wide range of sizes and types of construction, successfully meets almost any service requirement involving high temperatures, pressures, or severe abrasive or chemical action.

Bulletin No. SS-50, containing much useful information for manufacturers, engineers and machine designers, is yours for the asking. Write for it today.



WATER COOLED EXHAUSTS for PT boats also serve as vibration dampers to prevent line breakage. Made of 3" annular bronze seamless tubing with male fittings Tobin Bronze welded.

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Raymond Haskell

Raymond Haskell, an Associate Fellow of the Institute and Consulting Engineer of the Texas Company, died on April 7 at the New York Hospital at the age of 66.

Born in Baltimore on April 17, 1878, Dr. Haskell was educated at the Massachusetts Institute of Technology, receiving the Bachelor of Science Degree in 1903, Master of Science in 1904, and Doctor of Philosophy in 1907. He also held degrees of Bachelor of Science and Chemical Engineering from the Clarkson College of Technology. From 1908 to 1917 he was a scientific assistant in the U.S. Lighthouse Service and from 1917 to 1919 served the U.S. Navy as a civilian scientist. In 1919 he joined the Texas Company as Consulting Engineer, which office he retained until his death. During his term with the Lighthouse Service he developed new improvements in apparatus, and for the Navy his work was connected with the development and improvement of secret signalling devices.

Dr. Haskell was also a member of the American Chemical Society, the American Society for Testing Materials, the American Society of Mechanical Engineers, and the Society of Automotive Engineers, Inc.

Palmer Adams Hewlett

Palmer Adams Hewlett, an Industrial Member of the Institute and Export Sales Director of Consolidated Vultee Aircraft Corporation, died as a result of a heart attack on April 8, in Washington.

A native of Bath, N.Y., Mr. Hewlett attended the Rochester Business Institute and Columbia University. He entered the aircraft business in 1915 and devoted his entire business career to the industry, rising from a stock clerk to vice-president and sales manager. From 1915 to 1935 he was connected with the predecessors and subsidiaries of the Curtiss-Wright Corporation. In 1936 he joined Aircraft Export Corporation and in 1938 became Export Manager for Aviation Manufacturing Corporation, serving as Export Manager for companies that subsequently were merged into Consolidated Vultee Aircraft Corporation.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Professor in Aeronautical Engineering Department—Broad experience in the aviation industry needed. Address inquiries Dean, G. J. Davis, Jr., College of Engineering, University of Alabama.

Aircraft Instrument Engineer—Urgently needed. Top priority. Thoroughly familiar with design and operations of Automatic Pilots. Gyros and similar Robot Control Mechanisms. Submit details and qualifications at once. McDonnell Aircraft Corporation, 1703 Locust Street, St. Louis, Mo.

Wind Tunnel Model Men—Qualified wind tunnel model builders and/or designers for new small company. Desire men with extensive experience in wood and metal model work to close tolerances and in model project organization and planning. All models and instrumentation are for various aircraft companies and aerodynamics laboratories. Airmail complete qualifications and experience to Aerolab Development Company, 1992 Lincoln Avenue, Pasadena 3, Calif.

Structural and Electronics Engineers, Aerodynamicists, Design Engineers, all grades. New, vital project, U.S.N., location New York City. Send complete résumé or call or wire for interview. Statement of availability required. Postwar continuation. Address Dean D. Smith, Fairchild Engine and Airplane Corporation, 30 Rockefeller Plaza, New York 20, N.Y.

Aircraft Engineers—Experienced aerodynamicists; structural designers; senior drawing checkers; static test engineers; layout and detail draftsmen; senior stress analysts; technical illustrators; technical writer. These positions immediately available in critical war work at attractive salaries. Postwar prospects excellent. Applicants must comply with W.M.C. regulations. Address replies giving education, experience, background, age, and draft status to C. J. Libby, Administrative Engineer, Edo Aircraft Corporation, Terminal Building, Flushing, N.Y.

Aeronautical Engineers, Stress Analysts, Layout and Detail Draftsman—Excellent opportunities in the Engineering Division to carry out original design work on all phases of helicopter development program. Applicants must comply with W.M.C. regulations. Write stating education, experience, age, draft status to Administrative Engineer, Kellett Aircraft Corporation, Plant #2, Upper Darby, Pa.

Aeronautical Engineers—Experienced or semiexperienced stress, layout, and weights engineers for important positions in connection with designing of nonwrinkling sandwich aircraft structures. War and postwar applications. Write full particulars concerning education, experience, and salary requirements to Universal Moulded Products Corporation, Aeronautical Engineering Division, Bristol, Va. Attention: Dr. R. J. Nebesar.

Engineering Pilot, with Army, Navy or Marine flight training is desired. Engineering education, preferably an aeronautical degree, pilot license to fly both single and multi-engined airplanes is required. Pilot must pass military aero-medical physical examination as some work may involve flights at high altitudes. Address inquiries to the Chief Engineer, Curtiss-Wright Corporation, Propeller Division, Caldwell, N.J.

Aircraft Engineers—Positions available in Clifton & Caldwell, N.J., for Tool & Gage Engineers. Also engineers for manufacturing process, production methods, also design engineers, Seniors & Juniors. Manufacturing operation sheet writers, designers, tool & gage; gage analysts, tool & gage draftsmen. Applicants must have Aeronautical Industrial Manufacturing experience. Must have certificate of availability. Call in person or write Employment Office, Curtiss-Wright Corp., Propeller Division, 143 Getty Ave., Clifton, N.J.

Detail and Layout Draftsmen, Stress Analysts, and Design Engineers needed for development work in the Engineering Department. Must be citizen, not employed in essential war industry, or have a certificate of availability from the U.S. Employment Service Office or the War Manpower Commission of your area. Address inquiries to Curtiss-Wright Corporation, Airplane Division, Buffalo, N.Y.; Attention: Director of Engineering.

Detail & Layout Draftsmen, Stress Analysts, Design Engineer, Assistant Project Engineer on development work in the engineering department. Address inquiries to Edo Aircraft Corporation, 136-48 Roosevelt Avenue, Flushing, L.I., N.Y.

Stress Analysts and Aerodynamicists—Required for aircraft design work U.S. Naval Aircraft Prime Contractor. Address inquiries to Box 297, Institute of the Aeronautical Sciences.

Assistant Professor—To teach Mechanics, Strength of Materials, and Physics in a small Mid-western College. Must have Master of Science Degree, preferably in Engineering or Physics. Salary dependent on qualifications and experience. Position permanent. Address inquiries to Box 291, Institute of the Aeronautical Sciences.

Engineers—Aeronautical, Mechanical Electronic Designers, Draftsmen, Checkers; wide variety of interesting work on essential projects. Excellent postwar opportunities. Manhattan location; W.M.C. rules observed. Address inquiries to Box 284, Institute of the Aeronautical Sciences.

Draftsmen—Four or five, wanted by large research and development organization; experienced in the lay-

EVEN ENGINEERS ARE FROM MISSOURI . . . Until they Fly behind it!

This Variable Pitch "Propeller with a Brain" Works Wonders in Performance . . . Automatically

YES, we can give engineers technical data from which they can figure, with mathematical precision, exactly how and why the Aeromatic Propeller works. *But it still seems too good to be true . . . until they fly behind it!* Then they get the feel of what they've figured and . . . YEAH MAN!

In terms of performance for your postwar plane, Aeromatic means one-fourth shorter takeoff runs . . . one-third higher rate of climb . . . cruising faster and farther at the most favorable altitude . . . all with minimum fuel consumption and engine wear. And it means long glides for happy landings . . . with an instantaneous change of pitch for a quick pickup if you overshoot the field.

What's more, it's important to remember that the Aeromatic Propeller requires no instruments . . . no controls . . . nothing extra for you to watch or do. It's the one and only propeller that lets your plane and engine deliver . . . automatically . . . *all* the performance that is built into them.

If you fly, or plan to fly, you'll want an Aeromatic Propeller on your plane. Write to your aircraft manufacturer about it today. And if you'd like our little get-acquainted folder, containing a diagram of the "brain" in an Aeromatic Propeller, don't hesitate to write to Aeromatic, 242 Scott Street, Baltimore 3, Maryland.

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Air Controlled *Automatic Propeller*

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out of aircraft structural members. Four or five years' experience required; knowledge of stress analysis desired. Experience in wing or fuselage group would prove satisfactory. Address inquiries to Box 282, Institute of the Aeronautical Sciences.

Aerodynamics Engineer—Practical experience wanted by well-known long-established mid-west manufacturer to conduct technical research and market development in ventilating and air-cooling division. Attractive salary for man of ability and ambition. Address inquiries to Box 275, Institute of the Aeronautical Sciences.

Mechanical, Chemical or Metallurgical Engineer, experienced in fabricating and bonding aluminum alloys, to function as project engineer in conversion of copper exchange heat devices to all aluminum construction for aircraft applications. Mid-west location, position permanent. Salary commensurate with experience and ability. Address inquiries to Box 271, Institute of the Aeronautical Sciences.

Contact Man—to aircraft industry, travel mid-west and east representing manufacturer of heat transfer equipment. Engineering and previous contact with aircraft industry desirable but not essential. State background and previous employers and enclose photo. Address inquiries to Box 266, Institute of the Aeronautical Sciences.

Aero & Mechanical Engineers—Large engineering firm engaged in military work with growing backlog of postwar jobs needs engineering personnel in all categories: Designers, Layout & Detail Draftsmen, Stress Analysts, Checkers, etc. Location Manhattan. W.M.C. rules observed. Address inquiries to Box 263, Institute of the Aeronautical Sciences.

Chief Design Engineer—Graduate mechanical engineer, experienced on automotive radiators, with established AAA-1 high production manufacturer of automotive radiators. Worth-while salary. Sound peacetime future with resumption of automobile production. Write in complete detail. Enclose recent (nonreturnable) photo. Address inquiries to Box 252, Institute of the Aeronautical Sciences.

AVAILABLE

Engineer—Visualizer. Has broad and varied experience in the application of industrial visual aids (graphic illustrations) to employee indoctrination, production, plant layout, tool design, methods, cost analysis, sales, and service manuals. Developed methods to prepare such drawings economically. Desires additional work from medium size company for own office. Address inquiries to Box 302, Institute of the Aeronautical Sciences.

Industrial Designer—Stylist. Varied experience in product and interior design. Recently completed redesign of series of aircraft-engine test equipment. Desires additional clients for aircraft accessories styling or small plane interior styling. Address inquiries to Box 301, Institute of the Aeronautical Sciences.

Works Manager or Executive Engineer: College education; 39 years of age; married and have family. Broad experience in Industrial Engineering; Management; Production and Engineering. Proved performance in capacities of Works Manager; Plant Manager; Executive Engineer; Plant Superintendent; Industrial Engineer and Experimental Research Manager. Nine years aeronautical; seven years steel fabrication (all phases); and three years' heavy construction experience. Extensive Army and Navy contacts. Now in East. Will consider any location including foreign. Statement of availability and references will be furnished. Address inquiries to Box 300, Institute of the Aeronautical Sciences.

Design and Development Engineer—Eight years' experience in aircraft-engine design and development as analyst, designer, chief design analyst, and project engineer. Desires work on aircraft gas turbine and reaction propulsion program. Ph.D. in mathematical physics, 1936. Release available. Address inquiries to Box 299, Institute of the Aeronautical Sciences.

Helicopter Engineer (B.S. in Aero. Engineering) 5 years' experience in helicopter theory, design, and construction; has just completed successful helicopter for small company; did entire design, stress, weights, and aerodynamics. Desires position in supervisory design capacity in reliable company. Address inquiries to Box 298, Institute of the Aeronautical Sciences.

Aeronautical Engineer, M.S. in M.E., 10 years' experience in research, stress analysis, aerodynamics, thermodynamics and allied subjects with prominent manufacturing concerns. Two years in charge of research on aircraft gas turbines, development, design and applications of gas turbines to military and commercial aircraft. At present employed as Chief of Analytical Department, consisting of Structures, Aerodynamics, Weights, Vibration and Test Groups on a Rotary Wing development with an Eastern manufacturer. Desire responsible position with company primarily engaged in development of gas turbine engines. Thirty-nine years old, married, two children. Will consider moving to West Coast. Address inquiries to Box 296, Institute of the Aeronautical Sciences.

Aeronautical Engineer and Consultant—Seventeen years in the aviation industry on military and commercial airplanes including development, design, administration and direction of engineering groups, company representative at Service procurement centers and engineering flight test experience. Desires a permanent and responsible position in engineering or engineering sales or as a technical representative in the aviation industry or allied field. Address inquiries to Box 294, Institute of the Aeronautical Sciences.

Chief Inspector—At two airframe manufacturers (prime contractors). Ten years' inspection experience with leading aircraft companies and C.A.A. Can comply with War Manpower Commission Regulations. Draft exempt. Available latter part of April. Address inquiries to Box 293, Institute of the Aeronautical Sciences.

Production Executive—Mechanical engineer with five years' administrative experience in all phases of aircraft construction including line assembly methods, Tool and Jig design and one year as Director of experimental. Served ten years as Works Manager of large plant fabricating precision metal parts for automatic actuating mechanisms. Thoroughly familiar with modern precision machine shop practice serving eight years as Plant Manager. Manufacturing experience totals 26 years. Automotive background. Enjoy a wide acquaintance among subcontractors in central and eastern area. Will travel. Address inquiries to Box 292, Institute of the Aeronautical Sciences.

Retired Marine Corps Officer—Thoroughly familiar with Carrier Type Aircraft and Navy Procedure, desires position, preferably as Field Service Manager, with Manufacturer of Naval Aircraft or allied equipment. More than 17 years' experience, best of references, proven record. Address inquiries to Box 290, Institute of the Aeronautical Sciences.

Engineer—Registered university graduate and professional aeronautical engineer. Ten years' experience in the aviation industry including airplane design, stress analysis and structures, aerodynamics and Director of sales, engineering and production in aircraft accessories field. Desires to make permanent connection as executive, design engineer, sales engineer, or technical representative in the aviation industry, or as an aviation manager or technical adviser in nonaviation industry. W.M.C. will be complied with. Address inquiries to Box 289, Institute of the Aeronautical Sciences.

Aeronautical Economics Research Worker—College Graduate, Economics Major, 5 years employed in Aircraft. Now working for Masters' Degree in Economics at N.Y.U. and employed in Aircraft. Desires connection with research staff involving

(*Continued on page 115*)

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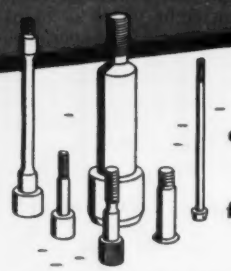

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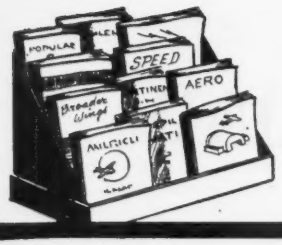

Periodicals

Accessories and Equipment

"Fairleads" for Supporting Aircraft Tubing. John Young. Details are given about a tubing and wire support that can be attached to practically any member of an airplane structure. This fairlead, a product of the Hughes Aircraft Company, is the result of a program inaugurated to develop a lightweight serviceable method of supporting tubing which would conform to ANH2 specifications. The method of installing the support is explained. Illustrations show the features of the support and its applications. *Industrial Aviation*, March, 1945, pages 35, 36, 94, 7 illus.

Utilization of Exhaust Heat Exchangers. Paul A. Pitt. This article is limited to some of the features of the exhaust heat exchanger and the effect of the installation upon the functions of the device. Beginning with brief comments about the earlier and less efficient methods of transferring heat from the engine for various purposes in the plane, a description is given of the larger capacity, more efficient exhaust-to-air heat exchanger now being developed. Heating capacity, advantages and limitations, ease of maintenance are outlined, and installations in commercial airplanes are described. Problems involved in the installation of such devices are discussed, as well as operating factors, performance specifications, and control systems. A typical performance curve showing heat-exchanger output at various power ratings and carburetor mixtures is reproduced. *Aero Digest*, March 1, 1945, pages 71–73, 162, 6 illus.

Design of Hydraulic Systems. Part III. Howard Field, Jr. The characteristics and applications of hydraulic motors and cylinders are analyzed in this third article of a series devoted to hydraulic-system design. Cylinder design is discussed in detail. *Product Engineering*, March, 1945, pages 196–201, 4 illus.

Aerodynamics

Compressible Flows in Aeronautics. John Stack. The Eighth Wright Brothers' Lecture was presented in Washington on December 17, 1944, by the Chief of the Compressibility Research Division of the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics. Following introductory remarks, the first part of the Lecture consists of a historical sketch that includes a statement of the problems first encountered in aeronautics as a result of compressibility. A summary of the development of the Laboratory facilities for such research is given.

In the second part of the Lecture, flows above critical speed are discussed and an explanation is made of the theoretic aspects of compressible flows. The significance of shock is also discussed. The Lecture concludes with an exposition of how compressible flows affect modern aerodynamics and includes some significant developments as applied to the design of high-speed aircraft.

At the conclusion of the Lecture, prepared discussions were given by Neil P. Bailey, Head of the Department of Mechanical Engineering of Rensselaer Polytechnic Institute; Dr. Hugh L. Dryden, Chief of the Mechanics and Sound Division of the N.A.C.A.; Dr. Norton B. Moore, of the Southern California Cooperative Wind Tunnel; and L. E. Root, Chief of the Aerodynamics Section, El Segundo Plant, Douglas Aircraft Company, Inc. Mr. Stack replied to these comments. *Journal of the Aeronautical Sciences*, April, 1945, pages 127–148, 32 illus.

The Effective Use of Aerodynamic Balance on Control Surfaces. L. E. Root. This paper is concerned with (a) an analysis of wind-tunnel data obtained from a 2-ft. constant chord control surface model constructed so that the separate effects of variation in aerodynamic balance overhang and movable surface nose shape could be obtained, and (b) the presentation of design methods leading toward the effective use of aerodynamic balance on control surfaces.

The basic airfoil section used is an NACA 0012 modified to 10.7 per cent maximum thickness by 12 per cent chord extension and straight-sided afterbody. These modifications were made in accordance with 1935 results from DC-2 flight tests which specifically indicated that flat-sided rudders or elevators were less subject to flow conditions causing undesirable oscillations, particularly when control forces had been substantially reduced through the use of aerodynamic balance. The nature of the overhanging balance effectiveness in reducing hinge moments is illustrated by presenting representative pressure distributions over a surface with and without balance at various angles.

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Using theoretic control surface parameters for simply hinged flaps as a basis, hinge-moment data from the model were analyzed to obtain empiric factors that correct for variations in aerodynamic balance and nose shape. Parameters are obtained for use in estimating three-dimensional control surface effectiveness and hinge moments with a degree of accuracy corresponding to the similarity of airfoil sections taken along the span of any specific control surface to the section tested, particularly with respect to movable surface shape. This method of calculating hinge moments has been checked by measurements on scale airplane models and was found to be reasonably accurate considering differences in hinge-line locations. Upon the basis of hinge-moment tests on sharp (A), medium (B), and blunt (C) noses, an intermediate shape, $(B+C)/2$, was chosen for design use. Comparison of control surface factors for this nose shape obtained from scale airplane model tests and from the basic model show good agreement.

With particular respect to air-transport operation, an important factor affecting the design of the movable control surface section is the degree to which the balance nose is subject to critical icing when the surface is held at a trim angle, such as in the case of a rudder after engine failure. From 1937 tests in the Goodrich ice tunnel using the 2-ft. chord model, an approximate relationship between balance nose shape and critical ice formation was suggested. Application of this limit to the $(B + C)/2$ nose-shaped rudders on present multiengined transports at best rate of climb with full asymmetric power indicates that the required rudder angles are not critical to dangerous icing conditions.

Additional factors affecting the choice of aerodynamic balance are discussed, and practical design limits applicable to elevators are given. From the basic wind-tunnel data, relationships of maximum up-travel, horizontal surface stalling, and free-control longitudinal stability to variation in aerodynamic balance and nose shape are determined. Application of these limits to typical airplane designs, in relation to the amount of hinge-moment reduction desired and the amount of balance recommended, shows the basic difficulty of reducing elevator control forces to acceptable magnitude and at the same time of providing enough elevator control for landing without exceeding the design limits.

To illustrate the use of aerodynamic balance on control surfaces, representative horizontal and vertical mean airfoil sections for eight Douglas airplanes are presented. Both the shape and amount of balance are clearly shown, as well as hinge location, maximum travel, control surface gap, and modifications to the basic airfoil. It is emphasized that proportionality of plan form and section will contribute to the more effective use of aerodynamic balance. To obtain maximum hinge-moment reduction for a given degree of unporting, it is necessary to avoid plan-form irregularities and movable control surface area aft of the hinge line which cannot be effectively balanced. *Journal of the Aeronautical Sciences*, April, 1945, pages 149–163, 18 illus.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

A Specific Chart for Flying Boat Take-Off Performance. John D. Pierson and Joseph E. Burghardt. The take-off performance of a flying boat is complicated in practice by the variety of possible combinations of the basic operating variables—weight, power, wind, and getaway speed. The desirability of a simple method of evaluating and presenting the required information is evident in view of the labor involved in computing performance for all the possible combinations of conditions involved.

From early studies of Diehl and others and from later correlations of take-off data (both calculated and flight test), it has become clear that there exists an approximately linear relationship between the reciprocal of the take-off time and the four operating parameters listed above. It is empirically shown in this paper that, in addition, the take-off distance is directly proportional to the product of take-off time and getaway speed.

These relationships form the basis for a new type of chart for the prediction of the take-off time and distance for a specific flying boat under any reasonable combination of the operating variables or for the reduction of flight-test data to a standard of comparison. *Journal of the Aeronautical Sciences*, April, 1945, pages 169–172, 4 illus.

The Glauert-Prandtl Approximation for Subsonic Flows of a Compressible Fluid. Hsue-Shen Tsien and Lester Lees. The writers advocate wider recognition of the potentialities of the Glauert-Prandtl method and its applicability to three-dimensional flow as well as two-dimensional flow, and beyond its present restricted application to thin-airfoil theory. The first part of the paper gives a general formulation of the three-dimensional problem with application to the calculation of wall interference in wind-tunnel testing at high speeds. The work discussed in the first part was prompted by a paper of the late C. Wieselberger, which appears to the writers to be erroneous. Reference is made to the limitations of studies by Prandtl and by H. G. Küssner, and the wing theory is re-examined from the usual point of view, involving the derivation of the Biot-Savart law for the compressible flow by the Glauert-Prandtl approximation.

This investigation constitutes the second part of the paper. The first-order effect of compressibility on the down-wash at an airplane tail surface is calculated for the simple case of a uniform wing-lift distribution as an illustration. Three-dimensional wind-tunnel wall corrections for subsonic free-stream velocities are also treated briefly. The induced velocity field of the helical vortex, which represents approximately the trailing vortex shed from a propeller blade, is then investigated and its effect on the aerodynamic characteristics of propellers is discussed. *Journal of the Aeronautical Sciences*, April, 1945, pages 173–187, 202, 18 illus.

Shock Waves in Aerodynamics. Howard W. Emmons. This paper reviews some of the physical aspects of shock waves as they affect the high-velocity performance of airfoils. It is shown that the conventional frictionless, adiabatic, irrotational fluid motion can admit shocks only as an added discontinuity. Real fluids with viscosity and thermal conductivity will admit shocks as a necessary part of the complete solution of high-velocity problems. A brief discussion is given of oblique shock waves and of the necessarily rotational motion in the region behind a shock wave. A few words are included on the subject of the critical Mach Number for airfoils. Finally, combustion, detonation, and condensation waves are mentioned. *Journal of the Aeronautical Sciences*, April, 1945, pages 188–194, 9 illus.

Equivalent Circuits of Compressible and Incompressible Fluid Flow Fields. Gabriel Kron. Equivalent circuits are developed to represent the following partial differential equations of mathematical physics

$$(1)\quad \text{Div } \bar{\mathfrak{z}}_{\cdot\nu} = Q;\ \text{curl}_{\,\nu} = \bar{\Gamma}$$

$$(2)\quad \text{Div } a\,\text{grad}\,\phi = b = b_1\frac{\partial^2\phi}{\partial t^2} + b_2\frac{\partial\phi}{\partial t} + b_3\phi + b_4$$

$$(3)\quad \text{Curl } c\,\text{curl}\,\bar{\psi} = d = d_1\cdot\frac{\partial^2\bar{\psi}}{\partial t^2} + d_2\cdot\frac{\partial\bar{\psi}}{\partial t} + d_3\cdot\bar{\psi} + d_4$$

under transient, sinusoidal, or steady-state conditions, thereby allowing their solution either by a network analyzer or by numerical and analytic circuit methods. In fluid dynamics these equations represent the steady potential flow of a *compressible* fluid when expressed in the hodograph plane or the general non-viscous flow of an *incompressible* fluid when expressed in the physical plane or space. (In representing the flow of a compressible fluid in the *physical* space, the networks have variable units, since the equations are nonlinear.)

The same equations and networks may be considered to represent *static* electromagnetic fields in current-carrying regions or in regions with stationary charges or poles. The second equation may also represent the conduction of heat (or diffusion) in a nonisotropic

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medium, or it may represent the general wave equation.

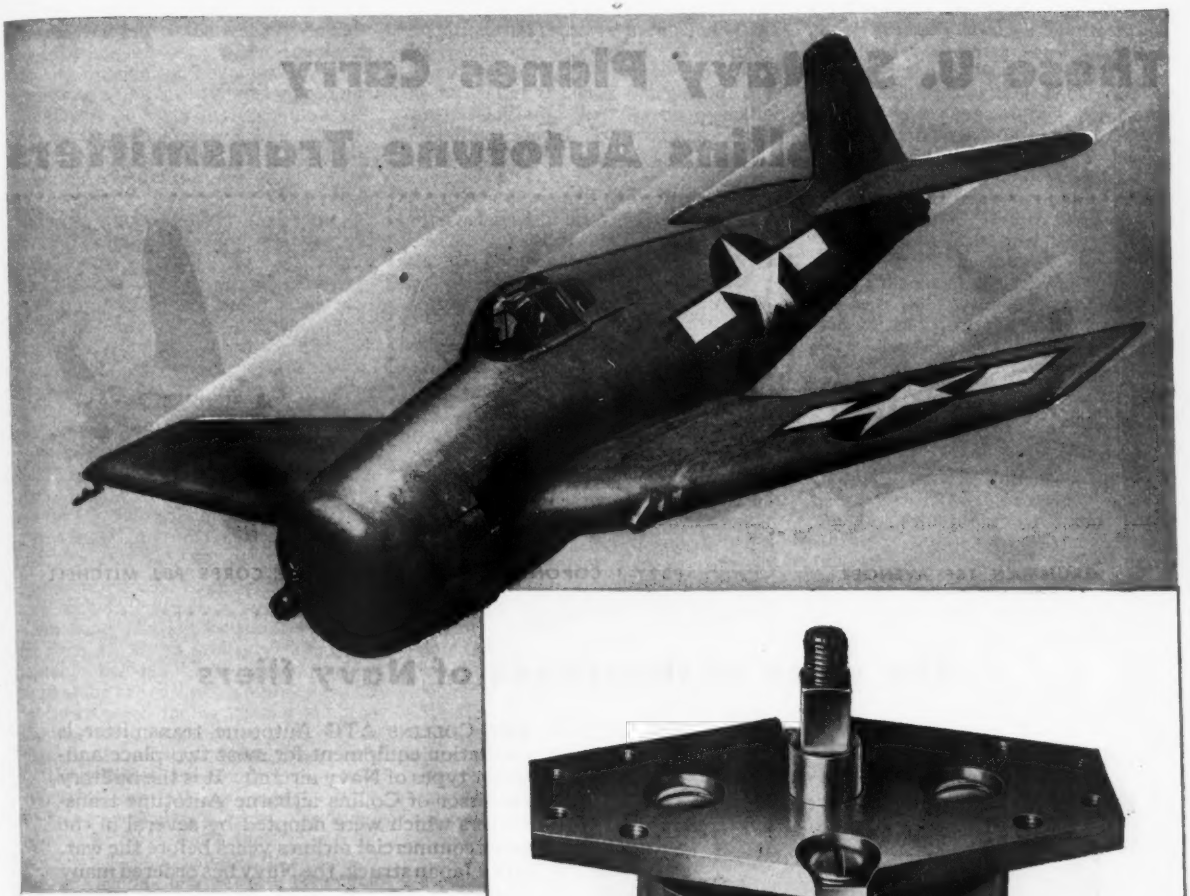
All networks are expressed in curvilinear orthogonal coordinates to simplify the networks in case of curvilinear boundaries and to express three-dimensional problems with axial or other symmetry by means of a two-dimensional network. The coefficients $\bar{\rho}$, a, and c are not scalars but elements of diagonal matrices, allowing special types of nonisotropic properties in the fields. All coefficients may be constants or functions of the independent space variables, thereby allowing nonhomogeneous fields. The fields may contain multiply connected regions, and a method showing how to represent Riemann-surfaces by equivalent circuits is given.

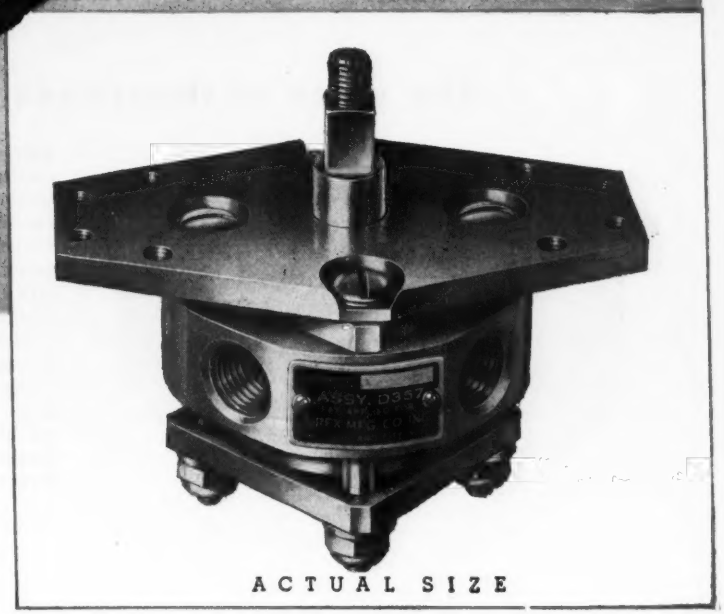
Most transient and steady-state equivalent circuits require only resistances, inductances, and capacitors, while some transient networks also require ideal transformers. The blocks into which space is divided may have arbitrary lengths in different directions. General nonisotropic fields and nonorthogonal reference frames require an extension of the present equivalent circuits.

Numerical methods of solving the equivalent circuits are given in another publication. In general the circuits may be used to check the consistency and accuracy of the results arrived at by other methods, approximate or exact. The unbalanced currents at the junctions (easily calculated) give a *quantitative* measure of the deviations from the correct answer. *Journal of the Aeronautical Sciences*, April, 1945, pages 221–231, 19 illus.

Numerical and Network-Analyzer Tests of an Equivalent Circuit for Compressible Fluid Flow. G. K. Carter and G. Kron. Of the circuits described in the companion paper, "Equivalent Circuits of Compressible and Incompressible Fluid Flow Fields," one was chosen for further study and testing. Because of recent interest in that field, the one selected for this purpose was the network representing the flow function ψ in the hodograph plane for compressible, potential flow. The equivalent circuit for this function is pictured. The circuit was first tested by calculating the current balance at several junction points of the network, using a distribution of ψ values calculated from analytic solutions of the original differential equation. This procedure having shown the validity of the equivalent circuit, the network was set up on the a.c. network analyzer and was used to solve a whole field from given boundary conditions; the solution so obtained matches the differential analyzer solution of the same field and thus shows the feasibility of solving such field problems with present network-analyzer equipment. *Journal of the Aeronautical Sciences*, April, 1945, pages 232–234, 2 illus.

The Thermodynamics of the Laminar Boundary Layer of a Heated Body in a High-Speed Gas Flow Field. Arthur N. Tifford. The thermal boundary-layer equations for a two-dimensional shockless gas flow are treated in a





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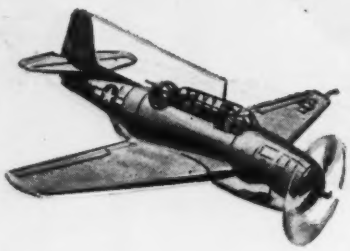

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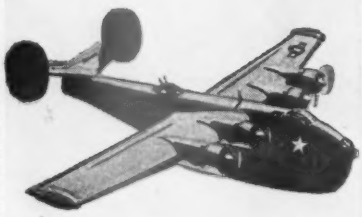

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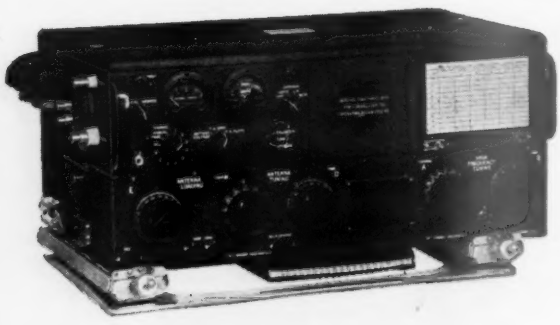

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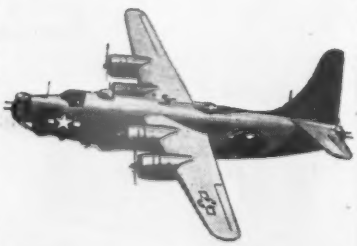

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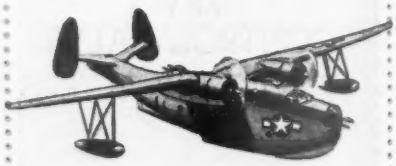

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manner similar to Falkner and Skan's general solution of the velocity boundary-layer equations. When the local velocity outside the boundary layer increases as a power of the distance along the surface, a particularly simple solution for the temperature field exists. A rather general differential equation defining the effect of the generation of heat by friction and shockless compressibility in the boundary-layer results. Some numerical integrations of this equation are presented, and it is found that the effect of the internal heat generation on the rate of heat transfer depends on the pressure gradient along the surface, as well as on the Prandtl Number of the gas when the latter differs from unity. In the absence of this internal heat generation, the difference between the gas stagnation temperature and the surface temperature is shown to be the temperature difference causing the flow of heat. The effect of the internal heat is only that of a correction factor on the stagnation temperature as the effective gas temperature. When the Prandtl Number of the gas is unity, no correction is required.

An exact solution for the heat transfer from a body of arbitrary shape, obtainable through Taylor series expansions along the surface, is outlined. The tables required for its general application remain to be computed from the derived linear differential equations. Until these tables are completed, a first approximation may be based on solutions for velocity fields of the type: $u_1 = cx^m$. It is shown that these solutions indicate an analogy exists between the *momentum loss* in the boundary layer and the rate of heat transfer despite the presence of a pressure gradient. This finding is at variance with the common belief that skin friction and heat transfer are analogous quantities. The latter is true only in the absence of a pressure gradient. The analogy is applied to the calculation of the variation of the local heat transfer coefficient over the front half of a circular cylinder, and good agreement with experimental data is shown. *Journal of the Aeronautical Sciences*, April, 1945, pages 241–251, 8 illus.

Lifting-Line Theory for a Wing in Non-Uniform Flow. Theodore von Kármán and Hsue-Shen Tsien. This article gives the details of a mathematical investigation carried out because the writers believed that a general and more satisfactory solution for the flow of a wing in a nonuniform stream could be obtained. The three-dimensional problem is again studied in this generalized case, introducing the modifications of Prandtl's fundamental concepts. *Quarterly of Applied Mathematics*, April, 1945, pages 1–11, 4 illus.

The Fundamentals of Flutter. Parts I and II. W. J. Duncan. This is a two-part article in which the theory of wing flutter is explained. In Part I, which is nonmathematical and complete in itself, an account of the cause of wing flutter is given in simple language. The discussion is illustrated by reference to experiments with an apparatus called the "flutter engine," which consists of an airfoil that is moved in roll and pitch by cranks on a single shaft. The angular setting of these can be varied so as to exhibit the vital influence of the phase relation of the motions upon the stability. Part I also contains a discussion of flutter prevention and of wing divergence.

In Part II the elements of the theory are explained in easily assimilable form and most of the mathematical details are given in appendixes that are devoted to phase and amplitude relations in flutter, the test function for stability, and the energy account. *Aircraft Engineering*, January, 1945, pages 16–20, 10 illus.; February, 1945, pages 32–38, 50, 3 illus.

On Theodorsen's Method of Conformal Mapping of Nearly Circular Regions. S. E. Warschawski. Reference is made to a method of conformal mapping of "nearly circular" regions developed by T. Theodorsen for use in connection with the problem of determining the complex velocity potential of the two-dimensional flow around an airfoil. Theodorsen reduces the problem of determining the mapping function to the solution of a certain nonlinear integral equation which is then solved by successive approximations. It is noted that the validity of the method from a mathematical point of view, such as the proof of the convergence of the successive approximations, has not been discussed. This paper represents an attempt to supply such a discussion. The actual results and proofs are set forth in the first eight sections of the paper and proofs of some of the auxiliary results cited in the text are given in a ninth section. *Quarterly of Applied Mathematics*, April, 1945, pages 12–28.

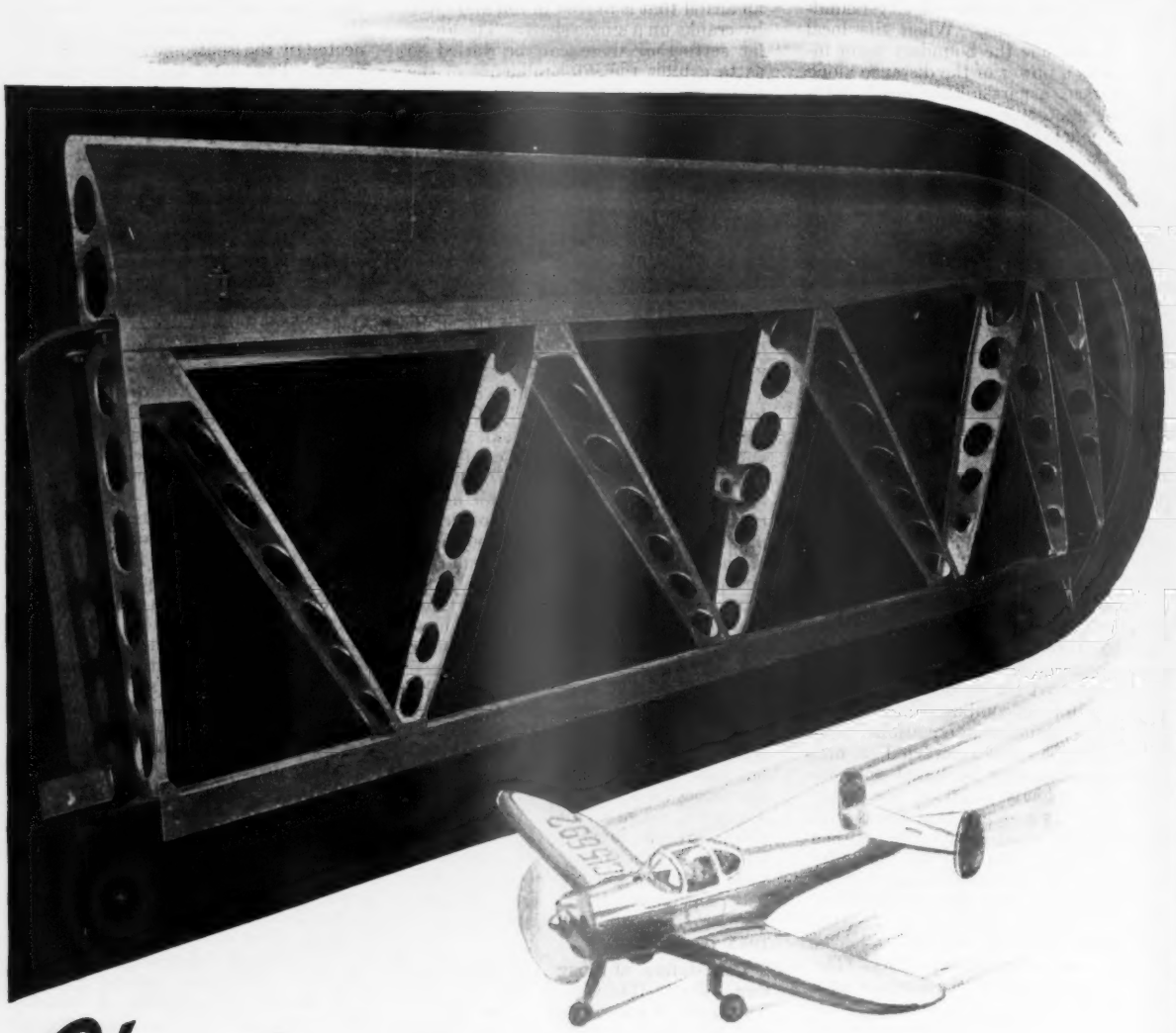
Calculation of Span Lift Distribution. Part III. Max M. Munk. The third of a series of articles shows how the method for calculating span lift distribution can be used for cases of unsymmetric distribution in which the right-hand lift distribution differs from that of the left. It is explained that the computation becomes two simple problems, one referring to symmetric conditions and the other to countersymmetric conditions. A table of multipliers for the countersymmetric condition is given, with an explanation of the way in which it differs from the symmetric table incorporated in the second article. Instructions are given for the preparation of a larger table which refers to any lift distribution, based on those two tables. A typical computation to illustrate the method will appear in the fourth and concluding article in the series. *Aero Digest*, March 1, 1945, pages 98, 206.

On Rotational Gas Flows. Andrew Vazsonyi. It is stated that, because airplanes are now attaining such high velocities, aerodynamic studies based on the classic theory of frictionless, incompressible, irrotational fluids have proved too restricted and interest has centered on the irrotational motion of frictionless, compressible fluids. It is noted that the term "compressible fluid" generally means a fluid for which the density ρ and pressure p are connected by the isentropic relation $p\rho^{-\gamma} =$ const. The writer then notes that the student of aerodynamics is frequently interested in supersonic phenomena and, because of the possible occurrence of shock waves, such flows cannot be described, in general, by isentropic, irrotational flows. A study of the motion of gases under less restricted conditions is presented. Sections of the article deal with the fundamental equations; vortex theorems for frictionless fluids; and adiabatic, steady, frictionless flows. *Quarterly of Applied Mathematics*, April, 1945, pages 29–37.

On Velocity Correlations and the Solutions of the Equations of Turbulent Fluctuation. P. Y. Chou. A method of successive approximation to the solution of the turbulence problem is developed. Three apparent difficulties connected with the Reynolds theory of turbulence in its original form and its applications are outlined. It is shown that the pressure fluctuation can be derived from the equations of turbulent fluctuation and is expressible as a function of the velocity fluctuation, the mean velocity inside the fluid volume, and the pressure fluctuation on the boundary. It is also shown that the decay terms can be put into simpler and more familiar forms by kinematic considerations. A general equation of vorticity decay is derived for the determination of Taylor's scale of the microturbulence which appears in the decay term; this equation was given first by von Kármán. The orders of magnitudes of the different terms in the equations of triple correlation are compared. It is found that the term involving the divergence of the quadruple correlation is actually smaller than the correlation between the pressure gradient and the two components of velocity fluctuation and can therefore be neglected as a first approximation. From a mathematical point of view the present program indicates that the turbulence problem can be reduced rigorously to a set of nonlinear partial integrodifferential equations, the solutions of which are very difficult to ascertain. In order to facilitate the solution of special problems, approximate forms of the integral parts of the equations are developed in a general way. These approximations, however, are only valid in regions not too close to the boundary of the moving fluid volume. *Quarterly of Applied Mathematics*, April, 1945, pages 38–54.

Air Cargo

Air Cargo and the Small Community. George F. Bauer. Managers of small airports are advised about facilities and services to be provided for the promotion of air-cargo business. Suggestions pertain to the transport of air cargo from the establishments of local manufacturers to the airports; warehouses for receiving, checking, weighing, recording, and storaging cargo; equipment for bringing the goods



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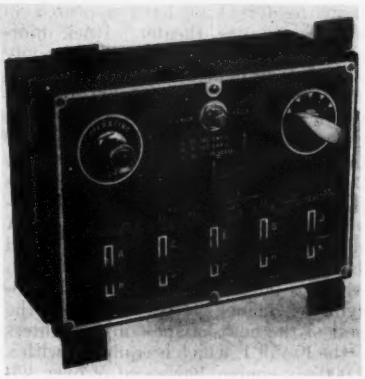
from the terminal out to the airfield and transferring them to the airplane; assortment of packages; and protection of merchandise from rain and snow. *Airports*, March, 1945, pages 48, 51, 2 illus.

Air Law

Aviation in the Courts. Leo T. Parker. Abstracts are given of recent court decisions on subjects of law having some relation to the aviation industry. The reported litigations show modern courts as considering that a person who signs a valid note is liable for payment, irrespective of minor differences between the payer and the payee; that under any and all circumstances of an accident the employer is not liable in damages unless the testimony proves conclusively that his negligence resulted in the injury; that an airfield company is a legal "bailee" which is duty bound to exercise a reasonable degree of care to safeguard parked airplanes; that municipalities desiring to construct modern airports should not, under normal circumstances, be restrained from doing so; that the taking of private property for public use is not restricted solely to such purposes as have to do with public health or safety but includes public welfare or necessity as well; that patrons of a municipal airport have no right to use the airport field or facilities except in accordance with reasonable rules adopted by the city for operation of the airport; that the National Labor Relations Board should not attempt to resolve ordinary differences between the parties to collective bargaining, particularly as to the meaning of the contract; that the character of an accident may be such as to impose on the airport being sued the duty to prove that the accident did not result from its negligence; that any payment on merchandise purchased by the Federal Government results in such merchandise being legally owned by the purchaser, in which event the seller may avoid certain state tax payments. Cases from which these opinions are derived are cited. *Western Flying*, March, 1945, pages 47, 48.

Air Power

The Defeat of the Luftwaffe in 1944. This review tells of the demolishment of the German air force during the year 1944. Reporting that the Luftwaffe was at peak fighter strength on January 1, 1944, and that German aircraft factories were producing more planes at that time than the Allies destroyed, the article traces the gradual extinguishing of the German air force until by the end of 1944 it was in no position to recover from its defeats. Five phases of the deterioration are noted: the destruction of German aircraft; the destruction of the aircraft industry; the transfer of Luftwaffe personnel to fill defects in ground forces; attacks on German oil resources; and



Manufactured by the Eclipse-Pioneer Division of Bendix Aviation Corporation, this electronic deicer control unit weighs only 6.5 lbs. and measures $8^{7}/_{8}$ in. long, $6^{5}/_{16}$ in. high, and $3^{3}/_{4}$ in. deep. The new unit is 10 lbs. lighter than the previous unit. Laboratory tests are reported to have shown that the instrument will function without adjustment for more than 1,000 hours icing time.

the "freezing" of German aircraft designs. The article also contains a report of the individual aircraft types that are being used by the German air force at present. *The Aeroplane*, February 2, 1945, page 144.

The Facts About the French Air Force. Lt. P. H. Clostermann. A French lieutenant gives some information about the prewar French air force. He describes its development and gives particulars regarding the number and types of aircraft in use when the war started. *Aeronautics*, March, 1945, pages 46–48, 10 illus.

How the AAF Uses Air Power. Brig. Gen. William W. Welsh. An interpretation of the basic principles underlying the use of Allied air power. It is explained why Allied air force is aimed first at the enemy's industrial resources, then at his air forces, then his supply lines, and, finally, at his ground troops. The pattern followed by the Allies, particularly the U.S. air forces, in carrying out this strategy is also described briefly. *Flying*, April, 1945, pages 21–23, 91, 92, 95, 5 illus.

Reaching the Heart of the Reich. Gen. Carl Spaatz. The Commanding General of the U.S. Strategic Air Forces briefly outlines some of the history and activities of the Eighth Air Force. Describing the military situation in Europe when this Air Force was activated, he explains the specific purpose of the Eighth and relates how it has accomplished its objectives in helping to destroy the enemy's ability to wage war. *U. S. Air Services*, March, 1945, pages 15, 16.

The Renaissance of the French Air Force. L. Graham Davies. This article deals with the activities of the French air squadrons operating on the western front as a part of the U.S. First Tactical Air Force, under a combined French-U.S. command. It includes data about the equipment, operations, personnel and airports of these squadrons, as well as an account of the revival of the French Air Force through the years 1941 to 1944. *The Aeroplane*, February 16, 1945, pages 196–198, 7 illus.

New Air Techniques in the Far East. Alexander Kiralfy. An analysis of American air strategy in the Pacific. Tactics by which U.S. air forces negated Japanese aerial plans in recent campaigns are explained. Emphasis is placed upon the superiority of offensive tactics over defensive ones. *Flying Aces*, April, 1945, pages 38, 39, 61–63, 3 illus.

Air Transport

Aircraft Operating Costs. Estimates of direct operating costs for the new civil Airspeed plane, A.S. 57, are given, together with an explanation of how these costs are calculated. Demonstrating that hours of utilization multiplied by speed is the potent factor in air-transport economy, these figures also show that economical operation can be combined with high cruising speed. Variables that influence operating costs are indicated in several illustrative graphs. *Flight*, February 22, 1945, page 207, 3 illus.

As the Crow Flies. Leighton Collins. Noting some of the problems involved in present proposals for providing air transportation to and from the less-populated centers, the writer proposes a national nonscheduled air-taxi system that could offer one-way charter service. He demonstrates the feasibility of such a system and its value to the public, to pilots seeking postwar jobs, to private owners wanting better and cheaper airplanes, to manufacturers of personal planes, and to air service operators. Questions of fares, types of aircraft needed, costs, and traffic potentials in connection with the plan are considered. *Air Facts*, April, 1945, pages 17–34.

Airline Flight Engineering. James J. Heatley. The role of the engineering test pilot in future air-line operations is described and his importance to operational efficiency is remarked. With notes on how such a unit should operate, the duties of the technical pilot group of an air-transport organization are outlined under eight major headings: (1) aircraft acceptance; (2) engineering piloting; (3) supervision of flight-crew training courses; (4) operations manuals; (5) coordination of pilots' operations complaints; (6) line inspection trips; (7) briefing; (8) accident investigation and special reports. *Western Flying*, March, 1945, pages 42, 43, 82, 2 illus.

Canada Crosses the Border. Burton Lewis. A discussion of the agreement between Canada and the United States allocating cross-border air-transport routes between the two countries. The agreement is conceded to be, on the whole, an equitable one and the following generalities are made: (1) U.S. lines have been favored in allocation of routes over which terminal-to-terminal services will be provided between

populous centers in the east; (2) Canada has the advantage of allocation of routes that are capable of feeding traffic into transcontinental and most prospective international services. It is pointed out that the potential advantage of the latter provision should not be underestimated. Allocation of the routes is illustrated by a map. *Canadian Aviation*, March, 1945, pages 66, 68, 116, 1 illus.

Air Transportation—A Full-Time Job. Edgar S. Gorrell. The views of the late President of the Air Transport Association of America are expressed in this fourth article in a series composing a symposium of opinions on postwar air transportation. In defending the conviction that the United States' postwar air-transport system should be operated only by air-line companies, he explained his belief that steamship companies, railroads, and other surface carriers should be denied anything but extremely limited participation in air transportation. He claimed that surface carrier interests cannot develop the full potentialities of air transportation; that their entrance into the field would only impair their surface operations; that restriction of air transport to companies engaged exclusively in air operations would result in competition between the various forms of transportation and therefore in lower rates, better service, and reduced service costs. He also indicated how air operations, instead of decreasing the business of other types of carriers, will serve to increase it. *Aero Digest*, March 1, 1945, pages 52, 53, 199, 201, 1 illus.

Airplane Descriptions

German Transport Aircraft. A compendium of German air transport types of the past 12 years. Beginning with data about the various planes used by the Deutsche Lufthansa A.-G. before the war, the article goes on to give some brief information about German transport aircraft used during the war. Designs being prepared for postwar use are also noted and attention is called to the division of opinion on whether the landplane or the flying boat is the better type for the purpose. *The Aeroplane*, February 2, 1945, pages 145–147, 13 illus.

Advanced Mechanical Design Insures Performance and Safety in Constellation. This is the first of a series of articles devoted to a design analysis of the Lockheed Constellation. The general design and performance characteristics of this transport are outlined. Detailed information is given about the tricycle landing gear, the wing flaps, the wing-flap actuating drive, and control mechanisms. Illustrations show the construction of the engine mounting and the exhaust system. *Product Engineering*, March, 1945, pages 156–162, 7 illus.

More New Japanese Warplanes Appear in Pacific Asiatic Combat. Comments are made about some of the latest models of Japanese army and navy fighters that have appeared in the Pacific war theater. Brief information is given about a stubby, heavily armed navy fighter known as the Jack 11, which weighs only 7,000 lbs. and which has been reported as having a top speed slightly more than 400 m.p.h., and the ability to climb to 20,000 ft. altitude in $5^1/_2$ min. It is powered with a 14-cylinder engine developing 1,800 hp. at sea level. A slightly heavier carrier or land-based Japanese navy fighter is the George 11, which is powered with a 2,000-hp. 18-cylinder engine. It is stated that the best of the new Japanese army fighters is the Frank 1, which is equipped with a 2,000-hp. engine, has speed of over 420 m.p.h. at 22,000 ft., and weighs 8,000 lbs. *Aviation News*, March 26, 1945, page 19.

The Bristol "Freighter" Aircraft. Parts I and II. Further details are given about the Bristol Type 170, which has been designed to meet the anticipated need for a simple, twin-engined, cargo-carrying airplane capable of operating from small landing grounds with a pay load of 4 to 5 tons.

In Part I it is explained that large doors opening sideways at the nose of the body give unobstructed access to the full width of the cargo hold, so that a truck can be run under the nose and unloaded directly onto the cargo floor. A traveling crane of 1,000-lbs. capacity is provided for lifting heavy packages and transporting them along the hold. Details are given about the fuselage, which has been constructed to render repair particularly easy. Information is provided about the design of the wings, the landing gear, and the Perseus engines, which are mounted in power-egg assemblies.

Part II is devoted to an analysis of the estimated cost of operating a fleet of these aircraft. *The Engineer*, February 16, 1945, page 138; February 23, 1945, pages 157, 158.

Endeavour 1945. A description is given of the modifications that distinguish the "Endeavour" from standard York airplanes. This aircraft is one that was built especially for the Duke of Gloucester's use as Governor-General of Australia. The modifications are noted to be mainly in the interior of the aircraft. *Flight*, February 22, 1944, pages 204a–204d, 6 illus.

Airports and Airfields

The General Theory of Stresses and Displacements in Layered Systems. D. M. Burmister. It is noted that the war-construction program has greatly increased the problems to be solved by the engineer in foundation engineering, and particularly in airport design and construction. These problems frequently involve the consideration of stresses and settlements in layered soil deposits. The well-known Boussinesq equations apply strictly only to homogeneous soil deposits. The general theory of stresses and displacements in a two-layer system is developed in order to provide the engineer with a useful tool that is more directly applicable to the analysis of actual conditions encountered in soil deposits. The basic equations of stresses and settlements are derived. The numerical evaluation of the surface-settlement equation for the simplest case of Poisson's ratio equal to one-half has been completed as the first of a series and is presented in the form of influence curves for the analysis of practical problems. *Journal of Applied Physics*, February, 1945, pages 89–94, 2 illus.

Airport Merchandising. Dudley M. Steele. The food and service department is discussed in the third of a series of articles investigating individual revenue-producing schemes for airports. Methods employed by the Lockheed Air Terminal to make this department (consisting of a coffee shop, sky-room restaurant, two cocktail lounges, and newsstand) a profitable one are described. *Southern Flight*, March, 1945, pages 62, 64.

A Giant Equipment Market. Lowell H. Swenson. An estimate of the types and amounts of equipment that will be used in the construction and maintenance of airports under the C.A.A.'s proposed national airport plan. This is demonstrated by two tables, one showing items and figures for maintenance equipment requirements, the other for construction requirements. *Airports*, March, 1945, page 44.

Will Super Airfields be Necessary for the Future? Arthur Fitzgerald. An investigation of the problem of how large airports will have to be to meet commercial aviation requirements in the postwar period. Indicating the difference between the conventional and "super" airfields, the writer bases his discussion upon five fundamental airport designs and offers a design of his own. He claims that, on the whole, airport needs have been underestimated and that present conditions seem to point toward requirements for fields with runways ranging from 6,000 to 10,000 ft. in length. *Aero Digest*, March 15, 1945, pages 102–105, 6 illus.

Airport Pattern. A four-stage development program is suggested for the master plan of an airport. Intended for airport construction on either rectangular or triangular sites, flexibility of the master plan is provided by including all engineering phases in the four preliminary studies so that changes can be made in advance of the main plan. *Air Tech*, March, 1945, pages 45–47, 4 illus.

Building an Airport—A Study of Costs and Revenue. Leslie A. Bryan. A survey of what it costs to build an airport, what revenue can be expected from the airport, and from what sources the revenue may be derived. For il-

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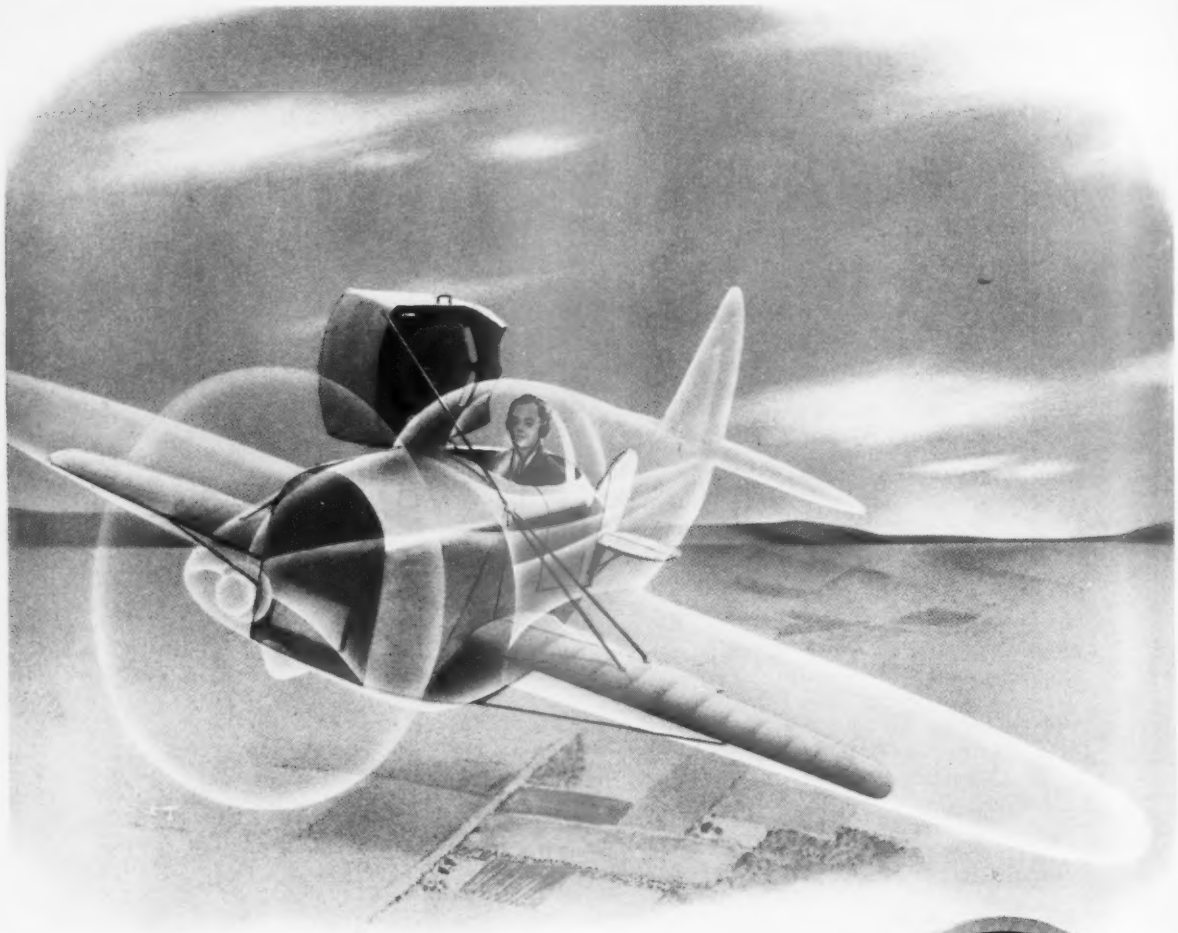

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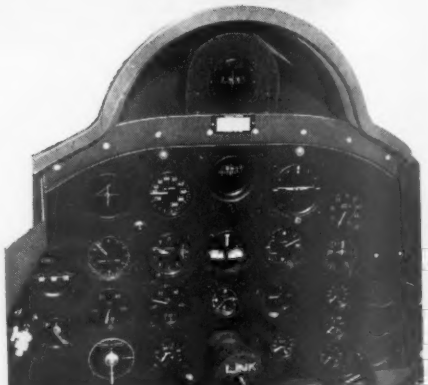

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lustrative purposes, the costs of an airport 2,640 ft. square containing 160 acres are estimated, with costs divided into 14 primary items. Revenue sources are classified into two groups, aeronautical and nonaeronautical. Fourteen aeronautical sources are suggested in a list. *Airports*, March, 1945, pages 27, 54, 55.

Airports for Canada. Wallace Ward. Some remarks about what is being done to meet the need for small airports in Canada. It is reported that, while no definite Canadian program for the expansion of the civil aviation network to include smaller centers has yet been announced, the recently created Air Transport Board has been given broad scope for the development of civil aviation generally and has the power to recommend to the government the extension of financial assistance for the promotion of air transport. Recommendations made by the Department of Transport for the selection and construction of Class I and Class II airports are outlined. *Canadian Aviation*, March, 1945, pages 46, 47, 3 illus.

How Far Apart Should They Be? Excerpts from the report of the Minneapolis-St. Paul Airports Commission on how close airports of similar and different types can be safely located with respect to each other. Differing from the C.A.A., which recommends that the relative lengths of the runways of each airport determine the separating distances, the Commission suggests that the airports should be separated according to a system based on the purposes for which they are used. *Airports*, March, 1945, pages 39, 52, 53.

Revenue vs. Costs at San Francisco. This report of the San Francisco Airport's expenses and revenues for the current fiscal year shows a loss of $45,276, and offers several explanations for such a loss. Three tables list the estimated revenues for the fiscal year 1944-1945, estimated expenditures for the fiscal year ending June 30, 1945, and airport charges. *Southern Flight*, March, 1945, pages 60, 64.

Engineers Convert Wrecked Airfield Into Huge Transport Base. Waldo G. Bowman. This is a description of how an engineer aviation battalion, aided by a small maintenance unit of Seabees, converted a wrecked airfield in the European theater into a large transport-plane base. Although handicapped by mud, the engineers patched and rebuilt runways, constructed taxiways, built parking areas and hangars, and demolished partly wrecked structures, at the same time keeping the field in operation. *Engineering News-Record*, March 22, 1945, pages 80–83, 6 illus.

Something New is Added. Harry M. Durning. The Collector of Customs of the Port of New York explains why a customs office was recently established at La Guardia Airport. It is stated that the establishment of such an office, the first of its kind, resulted from recognition of the requirements of an air-minded public, from anticipation of the great expansion of civil air transportation immediately after the war, and from a conviction that the port of New York is destined to play a principal role in the future of aviation in the United States. Particulars are given about the course of practical instruction in airport procedure established for the training of more than 100 customs inspectors and other personnel. The way the streamlined service is saving days in clearance is described. *Air Transportation*, February, 1945, pages 32–36, 1 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Maintenance of Airport Lights. J. S. Haney. Concluding installment of a two-part article advising on inspection, servicing, and repair procedures for airport lighting systems. Practical steps to be followed every 2 to 4 weeks in the regular inspection and care of airport lights to prevent failures are outlined. In addition, the importance and methods of aligning contact lights, means of keeping fixtures watertight, and problems connected with operating lights in heavy snow areas are discussed. Procedures for maintaining and repairing underground cable are noted. *Southern Flight*, March, 1945, pages 56, 57, 1 illus.

Airport Lighting. Robert B. Ely. This is an account of how a Class II airport at Urbana, Ohio, was lighted by converting a B-2 portable strip lighting set into a permanent installation. It is explained that the B-2 lighting set is of the type used by the Army and Navy to light advanced overseas air bases. The method of converting it for use at Grimes Field is described. *Aviation Maintenance*, March, 1945, pages 46–48, 9 illus.

Airports as a Business. R. V. (Bob) Trader. Some suggestions are offered regarding ways of increasing the revenue from a commercial airport operation. Included are suggestions pertaining to signboards and direction-arrows on highways; beautifying the appearance of the airport; restaurant and waiting-room facilities; a planned system for handling different phases of the operation; an advertising program; display of merchandise; selling of maps; and a personnel-relations program. *Aero Digest*, March 15, 1945, pages 60, 209, 210.

Airport Distribution and What It Means. John H. Frederick. An analysis of the need for airports in the United States based upon regional distribution. Stressing the point that smaller cities are in need of airports, the article demonstrates the public necessity for airport expenditures proposed by the C.A.A. to further civil and commercial use of the airplane. Three tables supplement the discussion: one shows the distribution of population by geographic divisions and proportion of population with scheduled air passenger service in 1940; the second, the distribution of existing airports by urban places; and the third, cities and towns in the United States by size-group, and those designated as scheduled air-line stops in 1940. *Southern Flight*, March, 1945, pages 48, 49.

Jack Berry Cleveland Airport. Procedures that have led to the successful development of the Cleveland Airport are described. The plans and airport philosophy of Major Jack Berry, Manager of the airport, as obtained through an interview, are set forth. *Air Transport*, March, 1945, pages 34–37, 3 illus.

Airports Also Serve People. Second article in a series presenting the major factors involved in the planning, design, and construction of the many types of landing facilities that will be required for postwar flying. This article, prepared by the editors of an architectural magazine, discusses the role of the architect in the planning and structural design of airports. The demonstrated need for an architect in the planning of an airport is based upon the conception of the airport as a multiphased community facility serving a whole series of human needs rather than as merely a landing facility to be fitted to the engineering requirements of the airplane. Various services, facilities, and accommodations that are deemed a necessary part of the modern airport are mentioned. *Aero Digest*, March 15, 1945, pages 54, 55, 207, 3 illus.

Airport Maintenance. Part III. Third in a series on airport maintenance prepared by the Airports Service of Region Four of the Civil Aeronautics Administration, this article deals with specific procedures to be followed in the maintenance of airport pavements. The causes of defective pavements and items that require checking are noted and methods of safeguarding against the defects, as well as repairing them, are indicated. Suggestions regarding personnel and kinds of equipment needed for maintaining airport pavements are given. Consideration is also given to the special care required for concrete pavements and different types of asphalt-surface courses. *Southern Flight*, March, 1945, pages 52–54, 5 illus.

Armament

Rockets for War. Lt. Col. L. U. Bailey. Recent developments in rocket weapons are reviewed. Various types of rocket ammunition, including those intended for aircraft armament, are described and illustrated. The effectiveness of rocket weapons in warfare

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is discussed. *Army Ordnance*, March-April, 1945, pages 233–235, 6 illus.

Avigation

Finding the Navigational Stars. Part III. Ben C. Kenny. The third part of a serial article on celestial identification proceeds from the study of the principal navigational stars to a study of the planets. The characteristics by which the planets may be recognized are defined. The vernal and autumnal equinoxes are explained and located. The positions of the planets Saturn and Jupiter with reference to certain of the navigating stars are described. Night photographs of the southern sky as observed from the United States in the early spring are clarified by diagrams. *Aero Digest*, March 15, 1945, pages 74, 75, 210, 3 illus.

Tomorrow's Avigation Faces New Factors. M. D. Lowenstein. It is noted that with the increased speed and range of aircraft expected in the future, certain terrestrial forces inherent in the rotation of the earth and the movements of the atmospheric masses will add errors in readings of navigation instruments and corrections will have to be made. This article contains an elaboration of the information given in the *American Air Almanac* with regard to what is known as the Z-correction for the bubble sextant, together with a detailed discussion of the external effects on masses moving over the surface of the earth. The deflection accelerations caused by the movement of an atmospheric mass from one latitude to another, and the effects of the earth's rotation, may be combined with another source of error called "gyroscope wander," and then tabulated. A lengthy explanation is given of these forces and their effects and of the methods followed in making the computations. *Aviation*, March, 1945, pages 183–185, 249, 250, 252, 6 illus.

Business and Finance

Offer New Finance Plan for Planes, Parts, and Repairs. Some notes about a plan, backed by the Cleveland Trust Company and Bank of America among other banks, for the time-payment purchase of aircraft. Covering 12- to 18-month periods, the plan reportedly provides terms similar to those customary for the financing of automobile purchases. Information pertaining to insurance, bill of sale, etc., is included with the data about financing terms. *Aviation*, March, 1945, page 171, 1 illus.

Civil Aviation

Civil Aviation Discussion. A report is given of a discussion of various aspects of civil aviation, held in London by The Royal Aeronautical Society on November 4, 1944. Following is a list of the subjects and speakers: "Training Personnel," by Brig. Gen. A. C. Critchley; "The Economics of Air Transport," Major R. H. Thornton; "Engines for Transport Aircraft," E. W. Hives; "Civil Aviation Aircraft," Roy Chadwick; "Ground Organisation," W. P. Hildred; "Education," Lt. R. C. Abel. The report also contains comments made by the participants in connection with the subjects discussed. *The Journal of The Royal Aeronautical Society*, February, 1945, pages 55–98.

Blueprint for a State Air Department. L. L. Schroeder. Advocating the right of the state governments to a major part in the control of civil aviation, the Commissioner of the Minnesota Department of Aeronautics gives his views as to the functions of the state in such control. He also describes the provisional organization of the Minnesota Department of Aeronautics as a suggested organizational setup for carrying out these functions. The discussed plan provides for five major state aviation departments: administrative; engineering; clerical; promotion and regulation; operation and management. *Flying*, April, 1945, pages 30, 96, 98, 100, 1 illus.

Fraudulent Gas Taxes Should be Eliminated. John R. West. A protest against what is called the injustice of state taxes on aviation fuel and the claim that monies so collected are not generally used for the furthering of aviation. It is the writer's opinion that only the Federal Government should assess taxes on aviation fuel, that these taxes should be uniform, and that revenue derived from them should be used for the development of aviation and the building of facilities necessary to it. In discussing the evils of the present aviation-fuel taxation system, he condemns the "refund" provisions made by some states as doing more harm than good in alleviating the situation. A summary of state aviation-fuel taxes and their disposition is given. *Southern Flight*, March, 1945, pages 44, 45.

The "Whys" of CAA Written Exams. Carol Sleicher. The nature and purpose of C.A.A. written examinations for pilots' licenses are explained. Interpreting the value of "objective"-type tests, the writer also gives assurance as to the fair, accurate marking of the C.A.A. tests and tells how items are selected for inclusion in the examinations. *Western Flying*, March, 1945, pages 76, 78.

Planting by Airplane. Tom Ashley. A description is given of an invention that is stated to make possible the planting of all types of seeds from an airplane, with provision for safeguarding the seeds from destruction before germination. Originated by Dr. Lytle S. Adams, this development is based upon the use of a seed "pellet," with the sowing of the pellets by a centrifugal machine attached to the bottom of the airplane.

The pellet consists of seed germ, from which the shell and chaff have been removed, coated with a mixture of soil containing growth-promoting vitamins and chemicals to repel insects and animals. Round in shape, it has mass and weight sufficient to bury itself when dropped from the air onto soft ground. Planting is done immediately following a rain. *Southern Flight*, March, 1945, pages 30, 31, 72, 6 illus.

Those Horsepower Ratings. Wolfgang Langewiesche. The present system of rating pilot skill according to the horsepower of the aircraft is criticized. Reviewing the factors that necessitate skill on the part of the pilot, the author points out that ratings based on any one factor would be as inconclusive as the power rating and advocates that a license gained on a conventional airplane be valid for any conventional airplane. His solution is that a commercial or private pilot having adequate skill, judgment, and familiarity with the airplane is a safe pilot with whom to fly, regardless of the power rating. He proposes that the horsepower ratings, with their implied guarantee to the passenger, be abolished and contends that such a measure would lead to fewer airplane accidents rather than more. *Air Facts*, April, 1945, pages 56–58, 60–62, 64–66, 68–70, 72, 73.

Used or Misused? Potential buyers of used airplanes are advised on seventeen points that particularly require checking when investigating the airworthiness of the plane. In addition, a few special admonitions are offered regarding used aircraft released for sale by the military authorities. *Air Tech*, March, 1945, pages 24–26, 17 illus.

The Chicago Civil Aviation Conference. J. Parker Van Zandt. The entire February 15, 1945, issue of *Foreign Policy Reports* is given to a report by the Director of Aviation Research of the Brookings Institution on the International Civil Aviation Conference held at Chicago, November 1–December 7, 1944. In addition to his summary of the proceedings and comments on the results accomplished by the Conference, the full text of the Convention on International Civil Aviation and the International Air Transport Agreement are printed. *Foreign Policy Reports*, February 15, 1945, pages 290–308.

So You Want to Start an Airline? Edward E. Slattery, Jr. Procedures to be followed in applying for new airline franchises are outlined and Civil Aeronautics Board requirements for instituting a new air-transport service are noted. *Flying*, April, 1945, pages 48, 49, 145, 148, 1 illus.

A Plan for British Civil Aviation. Part II. Colin Richardson. Concluding half of a two-part article urging the immediate inception of a civil aviation program for Britain and outlining primary features of such a program. Part II deals with suggested

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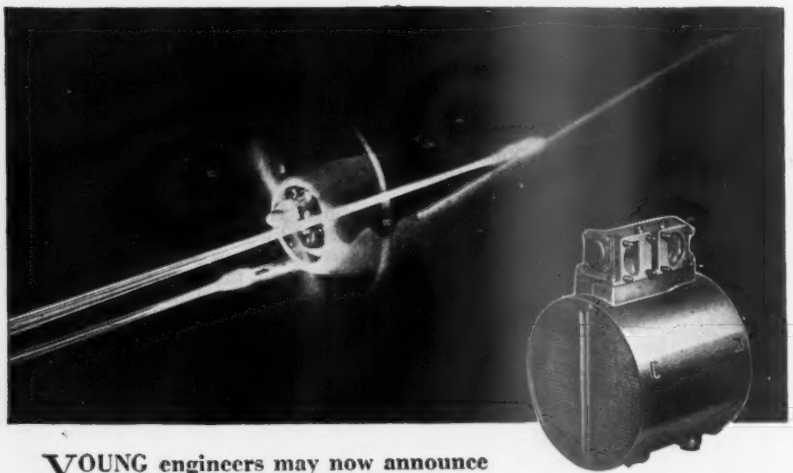

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routes, types of aircraft that will be required, flying schedules, and facilities for increased comfort and service to passengers. The advantages of night flying are noted to show why night flights are advocated for most scheduled long trips. In the detailing of routes, attention is concentrated mainly upon those to be operated by the British Overseas Airways Corporation. *The Aeroplane*, February 2, 1945, pages 136–138, 5 illus.

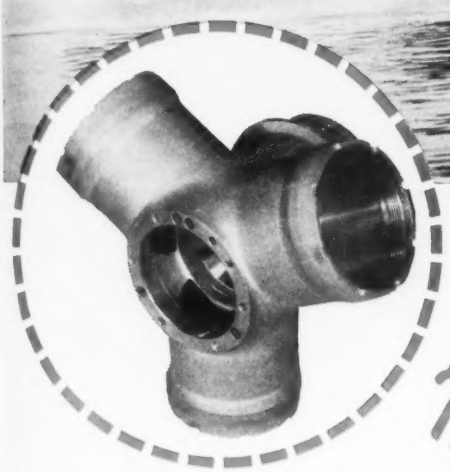
Aerogeology in Mineral Exploration. William S. Levings. The entire October, 1944, issue of the *Quarterly of the Colorado School of Mines* is given over to a study of that branch of geology that deals with the study of the earth's surface based upon visual observation or photographs from the air. The writer has endeavored to bring together in a single article a large amount of pertinent information heretofore scattered widely throughout other publications and he has overcome to a considerable extent the deficiencies in published data by compiling information from men holding key positions in the mineral industries. The primary purpose of the paper is to emphasize the possibilities of geologic observation from the air, with special reference to aerial photographs taken from moderately great heights, as an accessory to the modern equipment of the scientific explorer for mineral deposits.

After a brief survey of the various types of aerial photographs and of aerial equipment and flying routine, the advantages of the air view, as contrasted with that obtainable on the ground, are developed in detail. The conditions under which geologic inferences from the air are justified and the various criteria that serve as a basis for such inferences are discussed from the point of view of experienced observers in this field. The necessity for qualified interpreters for satisfactory results is stressed. Salient features of the aerial photographic map are indicated, as explanatory of their utility as base maps in all phases of prospecting and development operations.

The interrelationship of the factors governing the methods of aerial exploration is pointed out, and the methods applied in oil exploration and development are broadly contrasted with those in the search for ore deposits. *Quarterly of the Colorado School of Mines*, October, 1944, pages 7–77, 13 illus.

Companies

China's Aviation Industry. Lois Thomas. Although containing some data about other Chinese enterprises in the field of commercial aviation, this article is primarily concerned with the China Aircraft Corporation of San Francisco, named as the first Chinese-owned and operated airplane factory. Information about the firm's establishment and organization; facilities; personnel; executives; affiliation with the Chinese Government; subcontract-



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ing activities; and future plans is included. *Flying Aces*, April, 1945, pages 46, 47, 58, 59, 5 illus.

Control Equipment

Notes on Power Operated Controls for Large Aircraft. A. Gouge. It is noted that up to the present time the control surfaces of most large aircraft have been operated either direct or by means of control tabs. A general survey of modern control surfaces indicates that engineers have been "giving away a lot" in both weight and cleanliness in order that the pilot should control the aircraft direct. Some of the defects of controls operated directly by the pilot are mentioned. The application of an irreversible control unit adjacent to the control surface, which would eliminate the necessity for trimming tabs and mass balance, is discussed. Consideration is given to two approaches to the application of power-operated controls: (a) the use of power to multiply the force the pilot applies to the controls, and (b) the complete use of power, which would leave the pilot with no load or an artificial one graded to suit requirements. *The Journal of The Royal Aeronautical Society*, February, 1945, pages 51–54.

Hydraulic Remote Control. C. G. Hebel. Developments in remote-control systems are reviewed. The single-tube, balanced remote-control positioning system is described, and information is given about methods of preventing control movement caused by expansion and contraction of the hydraulic fluid because of temperature changes.

Details are given about an electro-hydraulic design that produces "localized compensation" at the receiver by inserting an electrically operated solenoid valve in a single-tube system. *Industrial Aviation*, March, 1945, pages 32, 34, 97, 3 illus.

Automatic Electric Control of Engine Temperature by Cooling-Flap Positioning. Russell A. Gund. A detailed description is given of a system for the automatic control of aircraft-engine temperature by cooling-flap positioning. The system belongs to the electrical class but may comprise a hydraulic actuator as its final element. It is explained that the action is not on-and-off but of the type that recalibrates the temperature-measuring element as the flaps assume successive positions. Information is given about the components of the system and the principles on which the system operates. The functions of the various components are described. *Instruments*, March, 1945, pages 159, 160, 162, 164, 166, 168, 10 illus.

Design

Taylorcraft's Liaison Planes—the L-2 Series. Part II. Final half of an article analyzing the design features of the Taylorcraft L-2 series of lightplanes. Components that are examined include the engines and parts connected with the installation and operation of the engines; propeller; exhaust and heater systems; aileron, elevator, and rudder and trim-tab control system; adjustable "glide control" spoilers; tail wheel; radio system. Figures giving the weights of the various models in the series, their wing loadings, service altitudes, and operational ceilings are listed. Diagrammatic drawings illustrate the discussed details. *Aero Digest*, March 1, 1945, pages 76–79, 9 illus.

Future Trends. R. G. Worcester. A brief summary is given of general trends in various phases of aircraft development. The survey includes consideration of fuels, wings, engines, jets, instruments, undercarriages, propellers, and other equipment. *The Aeroplane*, February 16, 1945, page 206.

Design Analysis of the Curtiss-Wright CW-20E. Willis L. Wells. Design features of the postwar commercial version of the Curtiss Commando are analyzed. It is noted that the backlog of experience gained with the C-46 in war operations has been transferred directly to the design of the CW-20E. How this twin-engined transport has been designed for low operating costs is described. The performance is stated to be particularly outstanding on flights up to 700 miles. The top speed of the plane is 286 m.p.h. and the cruising speed 251 m.p.h. at 14,000 ft. altitude. Features described include fluorescent lighting, a new "dolphin" nose, improved control surfaces, and passenger comfort aids. Sections of the article discuss the construction of the windshield, the flight controls, cabin, galley, power-plant group, and the oil and fuel systems. Illustrations reveal the construction of the various components. *Industrial Aviation*, March, 1945, pages 7, 8, 10, 12–14, 16, 18–23, 22 illus.

The Geometry of Geared Tabs. C. F. Allen. It is explained that in the preliminary layout of a control surface with a geared tab a certain amount of time must be spent in finding the necessary offset position of the tab control rod pickup in relation to the hinge center of the control surface. A simple formula is presented for determining the pickup position for any gear ratio. *Aircraft Engineering*, February, 1945, page 51, 2 illus.

Evolution of the Aeronca. Victor Boesen. The design history of the Aeronca series of lightplanes is traced from the C-2, first aircraft to be produced by the Aeronautical Corporation of America in 1928. Following the evolution of the plane through the Model K, Chief, and Super-Chief, the article also tells of the five categories of planes planned by this company for postwar sale. Information is included about the British branch and the Export Division of the firm; the performance characteristics of the Aeronca; the war applications of this lightplane; and the company's activities in manufacturing components for combat planes. A cross-section drawing of the Super-Chief supplements the article. *Skyways*, April, 1945, pages 34–41, 88, 12 illus.

Integral Fuel Tank Design. Allen S. Baker. Fundamental considerations in the design of leak-free integral fuel tanks for aircraft are outlined. With explanations of why the article is

Installation of metallic conductors on the Fairchild XC-82 Packet wing leading edge, for determining in actual flight time external heat-transfer characteristics in connection with the design of the internal anti-icing system.

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not concerned with caulked or welded tanks, the writer confines his discussion to design procedures for tanks that depend on a membrane system for fuel tightness. Included in the study is information about materials to be used for assuring the sealproof qualities of the tanks. A program of various tests is also advised for proving the design before production. *Aero Digest*, March 1, 1945, pages 110, 112, 206, 3 illus.

Flying Fuel Tankers—A Necessity. Lt. B. Orchard Lisle. The writer indicates the current need for a specially designed airplane to transport bulk fuel cargoes. He considers the feasibility of such an airplane and investigates the problems involved in designing it. Past developments and experiences with planes converted for tanker purposes are noted, with attention called particularly to the tanker being used by Transportos Aereos Centro-Americanos in Nicaragua. Potentialities of the specially designed type are exemplified by a theoretic flying oil tanker with pay load comparable to the C-69 Constellation. *The Aeroplane*, February 23, 1945, pages 221–223, 4 illus.

Northern Work Horse. R. F. Corless, Jr. The writer offers his ideas on the kind of postwar airplane that will be needed for various civil and commercial operations in the north of Canada. He reviews the nature of the work it would be called upon to perform and estimates the size of the market for such a plane. The writer's specifications include the following: A three- or four-place, high-wing monoplane with roomy fuselage, wide doors and good vision, and costing about $6,000. He states that the plane should have a pay load of about 600 lbs., a range without auxiliary tanks of about 450 miles, and the ability to perform efficiently on floats. It must be economical to operate but the writer does not consider high speed a requisite for the discussed aircraft. *Canadian Aviation*, March, 1945, pages 55, 56, 82, 2 illus.

Fighter Forecast. General developments in the design and performance of future fighter aircraft are prognosticated. Among the possible advances discussed are some pertaining to materials; the range of vision; the pilot's seat; the undercarriage; pressurization and oxygen systems; radio and electronic equipment; parachutes; controls; engines; and armament. *Air News*, March, 1945, pages 35–37, 72, 9 illus.

Cost Planning the Post-War Small Airplane. A. G. Tsongas and F. S. Macomber. The writers propose a plan by which a specialized group consisting of design engineering, industrial engineering, tooling, and factory personnel would assume the responsibility of selecting by orderly and detailed methods the most economical of several proposed designs. The group would also act as a consulting body available to the design engineers. They would gather the data necessary to measure costs of any given design, make a detailed cost analysis of each competing design, compare estimated cost per pound with similar parts made in the past, and follow up to see that low-cost ideas built into the aircraft were used through the tooling and manufacturing phases of production. *SAE Journal*, March, 1945, pages 157–165 (Transactions), 5 illus.

Design Analysis of the North American B-25 Mitchell. C. J. Hansen. Illustrated by numerous schematic drawings and tables, this is a detailed engineering analysis of the North American B-25 medium bomber series. It includes an account of the features that distinguish the two latest models of the series—the B-25H and the B-25J. Supplementing general descriptive data and specifications are particulars about the Mitchell's center-section structure, wing-center structure, fuselage forward section, fixed surfaces, movable surfaces, nacelles and engine mount, landing gear, hydraulic system, fuel system, oil system, and surface-control system. Other components and accessories that are examined at length are the power plant and propeller; electrical system; radio, gunnery, bombing, oxygen, instrument and photographic equipment; and cold-weather provisions. *Aviation*, March, 1945, pages 119–142, 32 illus.

The TBM-3. Part I. First installment of an article investigating the design and construction features of the TBM-3 Avenger. It contains a general description of the airplane, a summary of its principal dimensions, and some information about the production scheme by which it is manufactured, but is concerned mainly with details pertaining to the Avenger's wing sections, fuselage, tail surfaces, hydraulic system, engine mount, and oil system. Photographs and cutaway drawings illustrate the text. *Aero Digest*, March 15, 1945, pages 82–89, 215, 18 illus.

Connection to Anywhere. This article deals with planes for feeder air lines, investigating whether the size and speed of the airplane can be geared efficiently to short-line operation. Requisites laid down by the Air Transport Association of America and the Air Cargo, Inc., Committee of Aircraft Requirements for two types of feeder-line planes, ATA-A1 and ATA-B1, are outlined. Existing aircraft that can be modified to fulfill or surpass these requisites are named. The article also includes information about two new aircraft that have been designed specifically for feeder air lines in accordance with the specifications—the Lockheed Saturn Model 75 and the Martin Model 202. *Air News*, March, 1945, pages 56, 57, 74, 9 illus.

Make My Plane Useful. Charles Evans. Stressing utility as the most important characteristic of the postwar family plane, the writer claims that two aircraft of the past offer a design basis for three elements of utility: good take-off and landing qualities; large load-carrying ability; and low production cost. The two planes are the McDonnell Doodle Bug and the Waterman Arrowbile. The writer also gives his opinion as to the type of personal airplane needed for the popularization of flying after the war. This is specified as a four-place roadable plane retailing at about $1,000. *Flying*, April, 1945, pages 51, 52, 150, 152, 5 illus.

Electrical Equipment

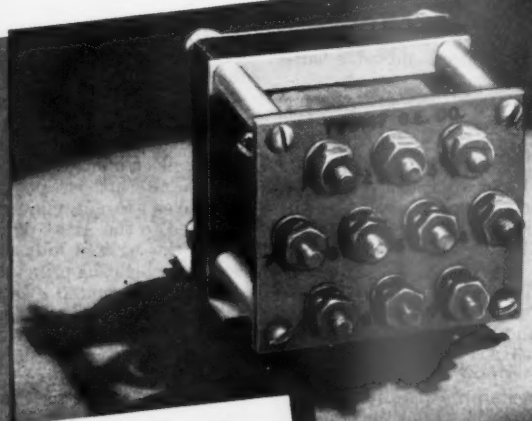
Electrical Equipment in Multi-Engined Aircraft. T. Kearns. The writer expresses his views regarding present British design practice in electrical equipment for large aircraft. These views are expressed in deliberately controversial language with the intention of arousing discussion from which benefit may result. The discussion deals with electrical systems, including cables and connections, and electrical apparatus. *Aircraft Engineering*, January, 1945, pages 21–25, 5 illus.

Aircraft Electric Systems. Part V. Francis S. Nelson and G. C. Close. The fifth part of a serial article discusses electronic devices for the control of aircraft. Stating that radio-controlled target planes are being supplied to the Army on a production basis, the writers indicate the many ways in which the principles of control equipment actuated by vacuum tubes are currently used and can eventually be extended to the operation of commercial aircraft. To date, the greatest stress on electronic applications has been to increase safety during flight, through such aids as directional-beam transmission, radar, electronic fire detection, and ice indicators. Other proved electronic aids include automatic flight controls, Gyropilots, turbosupercharger controls, propeller-feathering mechanisms, control-surface compensators, and similar devices. The principles of the more common devices are explained and their applications are reviewed. The operation of the electronic cowl-flap control is taken as an illustrative example, and as another a detailed explanation of the control equipment for the turbosupercharger is given. An electronically controlled ice-indicating system is described. It is indicated that the basic principles by which radio-controlled airplanes are made to perform such maneuvers as turning, banking, level flight, speed adjustment, and landing can be amplified to take over an important part of the pilot's responsibility and to enhance safety by lessening the hazards of human error. *Western Flying*, March, 1945, pages 50, 52, 54, 86, 5 illus.

Engines

Aircraft Bevel Gears. L. J. O'Brien. Points to be considered in the design of bevel gears for aircraft engines are discussed. It is stated that by following a few basic and well-established standards and practices the design, manufacture, and use of bevel gears are easily carried out. The conditions that make proper gear operation difficult in aircraft engines

A NEW, MORE EFFICIENT WAY to operate and control 6-volt instrument lights



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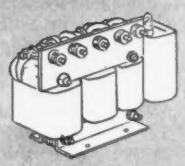

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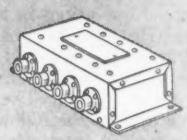
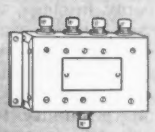
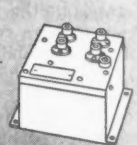






Transformers and ballasts for lighting indicators and instruments

Starting vibrators and ignition boosters

FOR THE WAR PLANES OF TODAY and THE COMMERCIAL PLANES OF TOMORROW

GENERAL ELECTRIC

403-79-5219

are outlined. These include improper lubrication, mating parts that are seldom mounted in the same housing, and the wide range of operating temperatures, combined with the use of plain bearings throughout, which cause a wide range of center distances. It is shown that these conditions now are taken into account when the gears are designed and consequently the service problem on bevel gears has been practically eliminated. *SAE Journal*, March, 1945, pages 184–192 (Transactions), 18 illus.

Limit of Present Fighters 500 mph; Jets, Turbines Promise New Speeds. A commentary in which the top speed of 1945 conventional fighters is discussed and particulars are given about the efficiency of modern aircraft engines and turbojet units. It is stated that improvements in power plant and refinements of design and construction have brought the 1945 models of conventional fighters into the 450–500 m.p.h. top-speed bracket. Reference is made to the advantages of turbojet units at speeds of 500 m.p.h. and above. A table of data on American-built reciprocating engines for combat aircraft is provided as a means of gaging the relative efficiency of these engines. *Aviation News*, March 19, 1945, page 21.

The Fundamentals of Flight-Induced and Forced Cooling. J. H. Brewster, III. This report was written to provide a better understanding of the possibilities, advantages, and limitations of both flight-induced and forced cooling for aircraft engines. Consideration is given to the essentials and fundamentals relating to both types of cooling for incompressible flow. Charts show the generalized effects of various cooling parameters on cooling power. Mathematical proofs and derivations are given in an appendix. *SAE Journal*, March, 1945, pages 138–147 (Transactions), 13 illus.

Starting Cold Engines. An account of the solutions evolved by the Army Air Forces' Cold Weather Testing Detachment for problems of "cold starting" aircraft engines. The described innovations were designed to eliminate the additional maintenance time required for preheating the engine before starting it when operating in sub-zero temperatures. They include (1) a method for dilution of the engine oil system; (2) a special fuel for priming and starting; and (3) a system of utilizing the special fuel in the most practical manner. *Aero Digest*, March 15, 1945, pages 94, 215; "60 Below," Kerryn King, *Air Tech*, March, 1945, pages 41, 42, 61, 9 illus.

Flight Technique

Flying the Vought Corsair. Part III. Wolfgang Langewiesche. Concluding a series on the piloting of high-performance aircraft, this article continues a discussion of the special performance characteristics of

the Vought Corsair. It contains detailed advice to pilots about how to guide the Corsair through approach and landing maneuvers. *Air Facts*, April, 1945, pages 36, 37, 40–42.

Fuels

Safety Fuels. C. D. Soltz. Stressing the importance of using less inflammable types of fuel than gasoline for aircraft, the writer indicates the feasibility of doing so. He discusses certain engine alterations and developments that would have to take place to accommodate such fuels but shows that there are solutions to these engine problems which would result in increasing the safety features of air travel. Probable German experience in direct-injection methods for safety fuels is noted. Typical specifications are given for an aromatic-blend type of safety fuel developed before the war, as compared with figures for 100-octane conventional gasoline and for Diesel-engine oil. *Flight*, February 1, 1945, pages 122, 122a.

Aviation Fuels—Types and Methods of Refining. Parts I, II, and **III.** This article discusses aircraft engine fuels, their methods of production, grades, and specifications of interest to air-transport operators. Part I is devoted to the chemistry and manufacture of these fuels. A chart is supplied illustrating the number of hydrocarbons it is possible to obtain from the paraffine series. Part II reviews the various grades of aviation fuels and discusses fuel specifications and their interpretation. In Part III the discussion of specification requirements is concluded with particular reference to those used primarily for quality control. A brief résumé is given of specific problems and the cooperative research work now being carried on in connection with aircraft engine fuels for air transport. *Air Transport*, January, 1945, pages 112, 115, 116, 119, 1 illus.; February, 1945, pages 111, 112, 114, 117; March, 1945, pages 119, 123.

Aviation Fuel Performance. W. J. Sweeney. How the performance of aviation fuels affects engine operation is discussed. The sequence of events in the combustion chamber which lead to knocking and consequent loss of power are enumerated. With the aid of charts, the writer explains why high-quality fuels improve engine performance and reduce maintenance requirements. The effect of mixture change on power and economy is discussed and adjustment of automatic carburetors to meet operating conditions is described. *Aviation Maintenance*, March, 1945, pages 54–57, 134, 6 illus.

Gliding and Soaring

The TG-4A. Randall N. Chapman. Design features of the "Yankee Doodle Two" glider, which is also known as the Army Air Forces TG-4A, are described. The writer tells how this glider was developed from the well-known Yankee Doodle model. The specifications of the Yankee Doodle Two are listed and how it differs from the prototype is explained. *Soaring*, January-February, 1945, pages 10–12, 3 illus.

Gliding and Soaring in Pre-War Poland. W. Z. Stepniewski. This is a brief review of gliding and soaring developments in Poland before the present war. An analysis is made of the reasons why gliding and soaring in Poland reached a higher state of development than in many other countries having greater resources. It is stated that the most important single factor probably was that the enthusiasm for flying on the part of the youth found favorable understanding among the grown people of Poland. *Gliding*, January, 1945, pages 8–11, 4 illus.

Gliding and Airline Piloting. Loren V. Petry. A comparison is made of the techniques used by glider pilots and pilots of powered aircraft in commercial operation. It is noted that, despite the great differences in the two classes of flight, there are many points of similarity in the application of what is termed precision flying. Comments are made about the reactions of the glider pilot and the transport pilot to the same weather phenomena and how a given set of flying conditions is treated by each type of airman. Incidents are described to show that the experience gained in gliding is often found valuable in commercial aviation. *Soaring*, January-February, 1945, pages 5, 6.

Storm Flight. B. Baranowski. An account of a soaring flight through a storm. The writer describes the meteorologic phenomena that take place and both the glider's reactions and the pilot's. He also advises what the pilot must do to meet the storm conditions. *Canadian Aviation*, March, 1945, pages 50, 51, 89, 4 illus.

Soaring Birds. John H. Storer. A discussion of some questions about gliding and soaring brought up through a study of bird flight with a slow motion camera. Photographs of soaring birds are shown. *Soaring*, January-February, 1945, pages 13, 14, 4 illus.

High-Altitude Flying

Continuous Flow Oxygen Regulator for High Altitude Flying. H. J. Hense. An article about the A-11

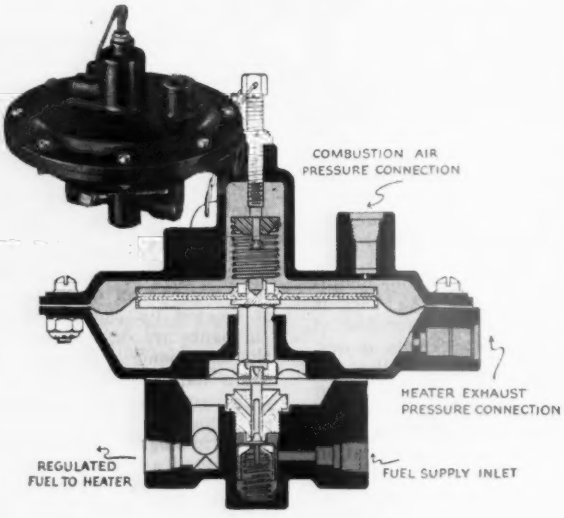
★ Dependable

More than 35,000 Janitrol Aircraft Heaters have been produced for military airplanes. Proof of their unmatched reliability is the fact that an increasingly larger proportion of Allied plane installations are Janitrols.

★ Long Life

Performance records reveal long, trouble-free and continuous service. Designed for 1000 hours operation, many Janitrol Aircraft Heaters have operated for upwards of 4000 hours and are still delivering highly satisfactory service.

The "Whirling Flame" that's flying



Improved Air Loaded Fuel Pressure Regulator

This new simplified design of control is typical of the continuous development work carried on by Surface Combustion engineers to further improve the remarkable performance of Janitrol Aircraft Heaters.

The control is compact and lightweight, it assures clean, efficient combustion over a wide range of speeds and altitudes.

By automatically maintaining a constant fuel and air ratio for a specified altitude, heaters light and burn efficiently regardless of the flying conditions.

Because this control need not be attached to the heater, one Fuel Flow Regulator can be used to control a series of heaters, where this is desirable.

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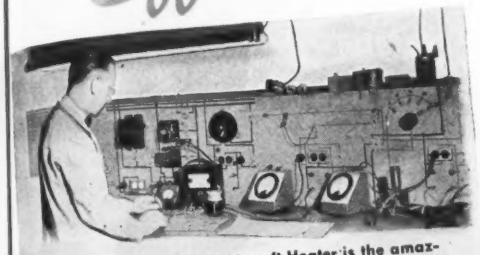
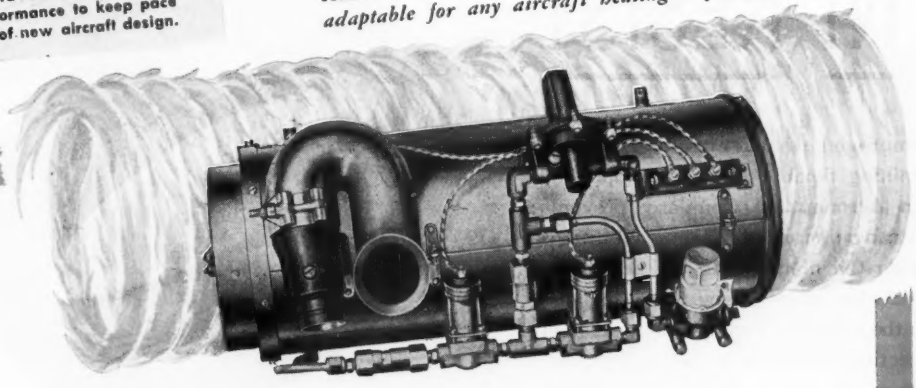
America's oldest and largest manufacturer of gas-fired industrial and domestic heating equipment, with more than 30 years' experience in combustion research, and in the application, control and transfer of heat.

★ *Efficient*



Heart of every Janitrol Aircraft Heater is the amazing "*Whirling Flame*" that has established new standards for heating efficiency. Even so, Surface Combustion engineers have not ceased to further improve heater performance to keep pace with the constant progress of new aircraft design.

A wide variety of models and sizes ranging from 15,000 Btu's to units with 185,000 maximum Btu per hour output capacity, comprise the Janitrol Aircraft Heater line. There's a unit ideally suited or readily adaptable for any aircraft heating requirement.



higher and farther . . .

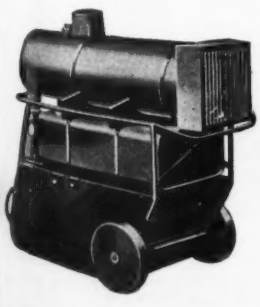
As America's planes reach new altitudes—fly faster and greater distances—the "*Whirling Flame*" flies with them. For we at Surface Combustion are constantly developing aircraft heaters to *keep pace* with the never ending progress of the aviation industry.

In our laboratories, through experimental field tests and many thousands of actual installations, continued study and research is resulting in heaters that not only meet the needs of today but also anticipate many of the requirements of tomorrow.

So whatever your plans in aircraft design or operation, now or in the future, look to Surface Combustion for *constant development* in aircraft heating.

Note to Postwar Product Designers

Planning busses, trucks, boats or trains in which effective mobile heat is required? Perhaps our unique experience with the "*Whirling Flame*" principle can help you with your problem. Write Surface Combustion for further information.



PORTABLE GROUND HEATER

This portable, self-contained ground heater furnishes reliable heat for engines, hangars, work shops, to dry out condensation, and for many other purposes. Will start and operate at temperatures as low as 40° below zero.

PORTABLE AIRCRAFT HEATER

Newest addition to the Janitrol line is a completely self-contained portable heater, including its own fuel tank and pump, for use up to 15,000 feet altitude. Because it is designed to operate with air taken from the inside of the plane, it is not necessary to engineer and build in exterior air scoops. Simply connect the heater to an electrical outlet, and you have immediate heat . . . even though the plane wasn't designed, or provision made, for a heating system.

Major Improvement

IN EXHAUST MANIFOLDS THROUGH NEW PARTS OF

NI-RESIST*

● *Originally, plain cast iron ball joints fitted with sealing rings were used in the universals but they required frequent replacement due to growth and corrosion from exhaust gases which attain temperatures of 1500° to 1800°F. and dimensional changes that allowed leakage. Now . . . sealing rings are eliminated. Leakage is prevented by machining closely spaced annular grooves on the outer surfaces of the Ni-Resist ball joints that fit into the stainless steel sockets.*

An improved exhaust manifold assembly containing flexible joints developed by Ryan Aeronautical Company prevents the transmission of engine vibrations through the manifold to the air frame. A collector ring receives the exhaust from the cylinders through stainless steel connecting tubes having "ball and socket" joints employing Ni-Resist balls. These flexible joints permit mounting the manifold onto the air frame.

Ni-Resist balls fitted into stainless steel sockets provide for the flexibility and free movement of the parts of the joint assembly and prevent leakage of the heated exhaust gases.

The alloyed balls adopted by Ryan several years ago and since employed in large quantities, have spectacularly demonstrated the ability to provide satisfactory resistance to wear, growth, galling and other thermal and mechanical influences involved in this application.

Both stainless steel and Ni-Resist are fortified with Nickel. Nickel imparts strength, toughness, hardness and resistance to heat and to corrosion. When you need a metal with *extra* qualities . . . think of Nickel . . . consult us on the use of Nickel or its alloys in your products or equipment. Send details of your problem for our recommendations.

*NI-RESIST—Reg. U. S. Pat. Off. by The International Nickel Company—Canadian Patent No. 278,180

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

automatic continuous-flow oxygen regulator, developed by the American Gas Association Testing Laboratories in collaboration with Alar Products. Weighing but 9 oz., this regulator is reported to deliver automatically the required various rates of oxygen flow for different specific altitudes without manual adjustment of any kind. It also starts to function automatically upon reaching an altitude of 10,000 ft. Details are given about its design and construction, functioning principles, operation, maintenance, testing, and repair. *Aero Digest*, March 1, 1945, pages 120, 122, 4 illus.

History

Blériot—My Father. Simone Rubel-Blériot, as told to Madeleine Raoul-Duval. Part I of a two-part biographic sketch of Louis Blériot describes Blériot's many early attempts to build a machine that would fly and tells how he finally achieved success. The aviator's activities are traced here up to the point where he was about to make his flight of July 25, 1919, across the English Channel. *Air Trails*, April, 1945, pages 24, 25, 58, 60, 8 illus.

Tailless Aircraft and Flying Wings. A. R. Weyl. The second and third articles conclude a series in which the evolution of tailless aircraft and flying wings is reviewed. In the second article the writer discusses tailless aircraft and flying wings developed by Russian, French, American, German, and English engineers. In the third article sections are devoted to the recent interest shown in flying wings, general conclusions, and the classification of tailless airplanes. *Aircraft Engineering*, January, 1945, pages 8–13, 21 illus.; February, 1945, pages 41–46, 30 illus.

Hydraulics

Causes and Prevention of Leaks in Hydraulic Tubing. Part II. Bernard J. McCabe. The second part of a serial article about the hydraulic system of an airplane considers the fittings and the difficulties to which they are subject, and their assembly and installation to make a complete hydraulic system. The similarities and differences of the Army-Navy (AN), the Air Corps (AC), and Naval Aircraft Factory (NAF) types of fittings are described and tabulated and advice is offered for the prevention of errors in selecting fittings.

With regard to the installation problems, the writer assumes that the lines have been correctly fabricated, with all defective material and workmanship eliminated, and proceeds to a discussion of the possible causes of leaks that are listed as (1) leaks between the fitting and the port, and (2) leaks between the fitting and the tubing line. Precautions to be taken to prevent such leaks are described at length. Tables give the correct sizes of seals for fittings, the proper assembly torques to be applied when tightening tubing-sleeve nuts, and recommended spacing of hydraulic-line supports. Sketches show different types of fittings and methods of installing them. *Aero Digest*, March 1, 1945, pages 138, 141, 154, 157, 7 illus.

Performance of O-Ring Packings in Rotary Seals for 3,000 lb. Pressures. Richard L. Hayman. This is a brief discussion about the adaptation of O-ring packings to rotary seals subjected to a pressure of 3,000 lbs. per sq.in., which include the seals applied to the swing joints in aircraft hydraulic systems. Test joints were constructed for use in determining the performance of the packing. Details are given about the tests and the results obtained. *Product Engineering*, March, 1945, pages 190, 191, 4 illus.

Inspection

Peering into Clipper Wings. Frank J. Zerilli. How Pan American World Airways is using X-ray inspection to locate hidden corrosion cracks in the wings of Boeing flying boats is described. It is stated that plans are being made to radiograph critical wing areas at each 750-hr. overhaul, and entire wings occasionally. Particulars are given regarding the equipment used and the method of X-raying the wings. Radiographs of wing sections are shown. *Air Transport*, March, 1945, pages 23–27, 8 illus.

Close Inspection Guards Production Quality. Herbert Chase. An account is given of the procedures followed by the Scovill Manufacturing Company in fabricating and inspecting nuts for aircraft. It is stated that the methods not only maintain high quality standards but also substantially reduce scrap. How segregation minimizes "contamination" with defectives is described. It is stated that in the case of a wing-style nut as many as 25 control dimensions must be checked constantly. Many nuts must be held within limits so close that unusual precautions are taken. *Wings*, March, 1945, pages 1450–1454, 9 illus.

Magnetic Crack Detection. J. E. D. Bell. Part I of a continued article which explains in simple terms the fundamental principles and practice of magnetic crack detection. This installment discusses the theory, test procedure, and conditions governing satisfactory crack testing. *Aircraft Engineering*, February, 1945, pages 58–60, 5 illus.

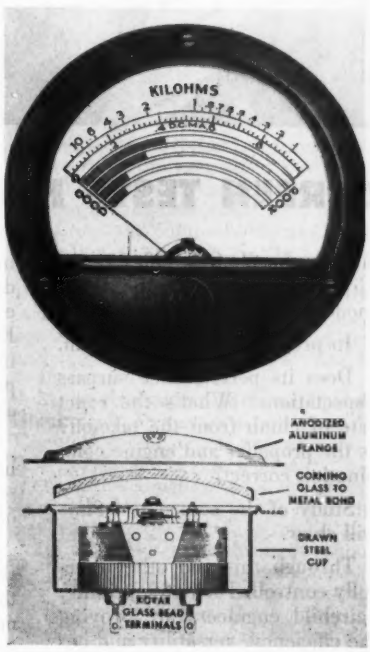
Inspection of Light-Alloy Forgings. A brief review of the duties of inspectors in the stamp shop and associated departments. The organization of an inspection system also is discussed. Layouts for job and batch cards are illustrated. *Light Metals*, February, 1945, pages 79–82, 3 illus.

Instrument Flying

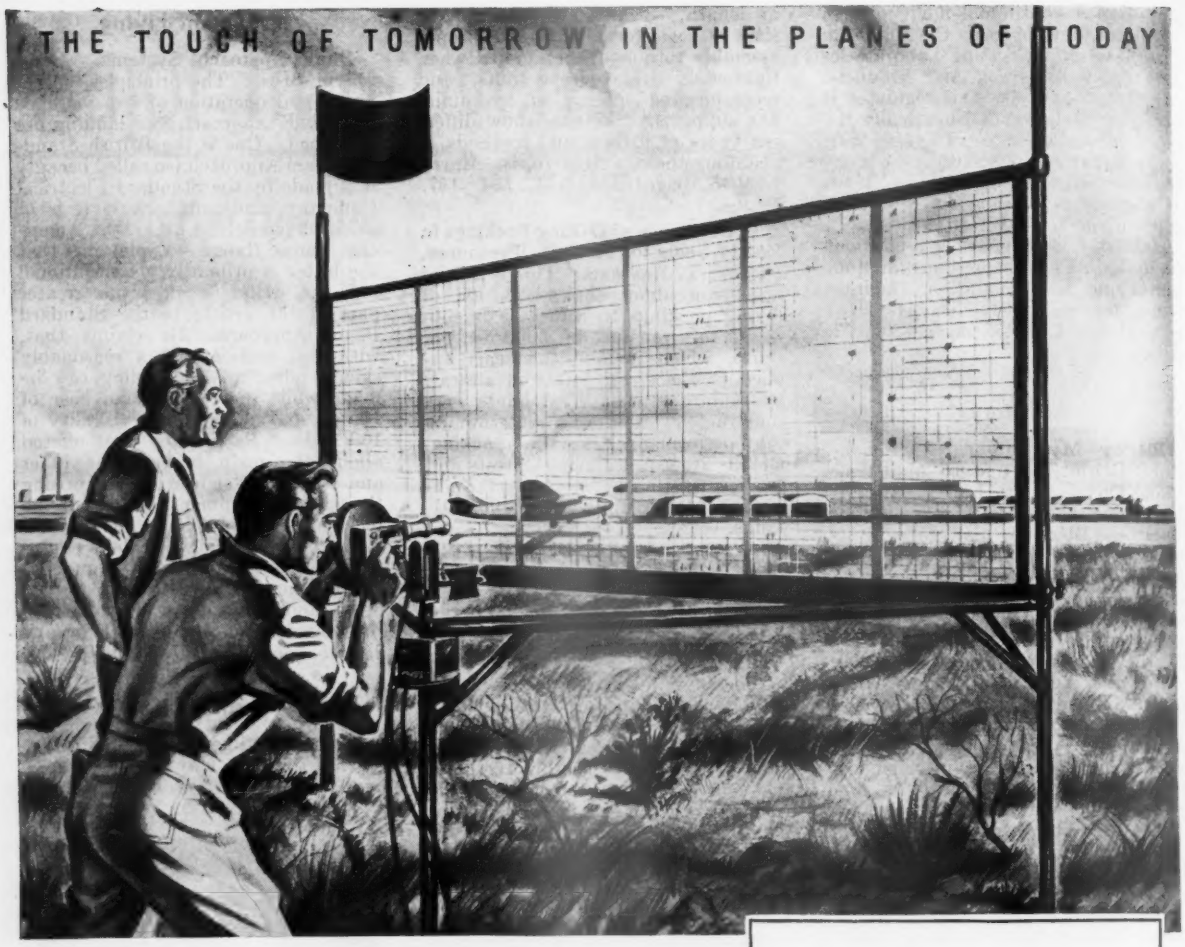
Blind Approach Systems. Capt. David Brice. The principles, equipment, and operation of two methods of "blind" approach and landing are described. One is the British Standard Beam Approach (so called because it is made by the Standard Electrical Company, and not because it is of uniform type); the other, the American Radio Range. Explaining that the latter is primarily a navigational aid, the writer devotes the greater part of the article to the Standard Beam Approach. He claims that, with this system and a reasonably skilled pilot, a safe landing can be made while there is a cloud base of 100 ft. and a horizontal visibility of 100 yds. Particulars are offered about the main beacon, the inner and outer marker beacons comprising the ground equipment, and about the receiver, control panel, and visual indicator comprising the plane equipment. The technique of approach, various methods of getting on to the beam, and the problem of control are considered. *The Aeroplane*, February 9, 1945, pages 165–167, 6 illus.

Instruments

Practical Altimetry. J. A. Browne. So that the pilot may better comprehend the application of corrections



By applying the principles of vacuum-type sealing, engineers of the Marion Electrical Instrument Company are said to have achieved true hermetic sealing in a group of newly perfected electrical indicating instruments. The cutaway view above shows a typical construction. The meter shown was alternately boiled and frozen for 12-hour periods for a total of 8 days. Maximum error in current on full-scale reading throughout the tests was 1/2 of 1 per cent. There was no moisture penetration.



SCREEN TESTS FOR A NEW STAR

Across the "screen" flashes an airplane powered by the latest model Ranger engine.

Its progress is recorded on film.

Does its performance surpass expectations? What's the exact rate of climb from the take-off? Is the propeller and engine combination correct?

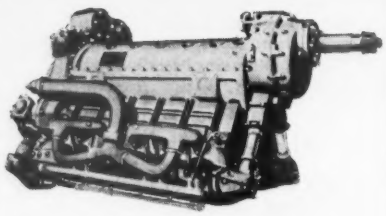
Study of the screen test films will show.

Through this and other carefully controlled scientific testing, Fairchild engineers are proving the efficiency, versatility and endurance of Ranger engines.

Constantly improved since its inception, the Ranger engine today packs more power into an even more efficient package. Fairchild research and engineering skill have developed a flying power plant that is "inline for the airlines."

The emphasis is on efficient horsepower production; length of service between overhauls; ease of maintenance; and economy.

Today, flying over test fields in ships that are basic designs for the airplanes of tomorrow, Ranger models, like all products of Fairchild research and experience, provide a "touch of tomorrow in the planes of today."



THE RANGER TWELVE

Skillful engineering has built these qualities into Ranger engines:

- High speed for *smooth* power
- Inverted for a wider field of vision
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- Precision construction and quality materials for long life

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to his altimeter readings, the subject of altimetry is reviewed from the meteorologic standpoint. The principle on which the altimeter operates is briefly explained. The writer then discusses the calibration of this instrument, consideration being given to the effects of surface pressure, the pressure-setting error, and the effect of temperature and temperature error. Other sections discuss the computation of true altitude by mean temperature, computation by observed temperature, and altimeter-setting systems. The article concludes with a summary of the subject and some test questions on altimetry. *Journal of Aeronautical Meteorology*, January, 1945, pages 46–58, 6 illus.

The Sonigage, a Supersonic Contact Instrument for Thickness Measurement. Wesley S. Erwin. This paper describes the sonigage, an instrument for rapidly measuring the thickness of metal sections in the approximate range of 0.020 to 0.400 in. with a maximum error of less than 2 per cent. Particulars are given about the principle on which it operates. It is stated that the instrument has been used to measure the thickness of propeller-blade walls and that it should be applicable to other inspection problems where rapid inspection of sections is necessary. *SAE Journal*, March, 1945, pages 25–27, 3 illus.

The Distant Reading Gyro-Magnetic Compass. Part I. In Part I of an article describing the design features of the distant reading gyromagnetic compass, early activities of the British Air Ministry in directing the development of this instrument are briefly reviewed. It is noted that in 1937 the Air Ministry requested the Automatic Telephone and Electric Company, Ltd., to undertake final development of the instrument and manufacture it on quantity-production lines. A compass capable of indicating a steady heading under all normal conditions of flight and in various parts of the aircraft simultaneously was required. Design details of the master compass unit are described and illustrated and operating principles are explained. *The Engineer*, March 2, 1945, pages 177–179, 6 illus.; "Notable Aircraft Compass," *Modern Transport*, March 3, 1945, page 7, 4 illus.

Landing Gear

Determination of the Axis of Rotation of a Skewed Axis Landing Gear. J. J. Jerger. Equations are presented which are intended to afford a simplified aid for the solution of the problem of finding an axis of rotation that will accurately locate the landing-gear wheel in certain desired retracted and extended positions, with no motion other than that of rotation about the axis. Simple formulas that determine the direction and position of the axis of rotation are given. These equations may be used directly and without a great deal of study, requiring only knowledge of the three sets of coordinates that locate the landing wheel in both the retracted and extended positions. Following an explanation of the equations and the symbols employed, an example is carried out in detail to illustrate the method. A complete draft of the derivation is included as an appendix for those who are interested in the mathematical phase of the solution. *Journal of the Aeronautical Sciences*, April, 1945, pages 217–220, 2 illus.

The size and massive construction of these U.S. Royal airplane tires used on a B-29 Superfortress are evident from this photograph. Nylon is used in the tire cord.

Design and Operation of FW-190 Gear Retracting Unit. Chester S. Ricker. These details of the design and operation of the Focke-Wulf 190 landing-wheel retracting gear reveal that the outstanding features of the unit are its compactness, light weight, and an unusual method of getting a high gear reduction in a small space. Measuring only 8⅝ by 13 in., the retractor has an overall reduction of 10,500 to 1. Its special design eliminates gear cutting and enables processing of the parts to be accomplished with a grinder, lathe, and drill press. Drawings and photographs illustrate the construction and operating principles of the retractor. *Aviation*, March, 1945, pages 156, 157, 4 illus.

Research and Tomorrow's Aircraft Undercarriage. Roy W. Brown. The diverse and complex requirements that the undercarriage of the modern aircraft must be capable of meeting are outlined. A description is given of a number of undercarriages that have been developed to meet these requirements. The extensive laboratory tests that have resulted in their development are discussed. *SAE Journal*, March, 1945, pages 177–183 (Transactions), 10 illus.

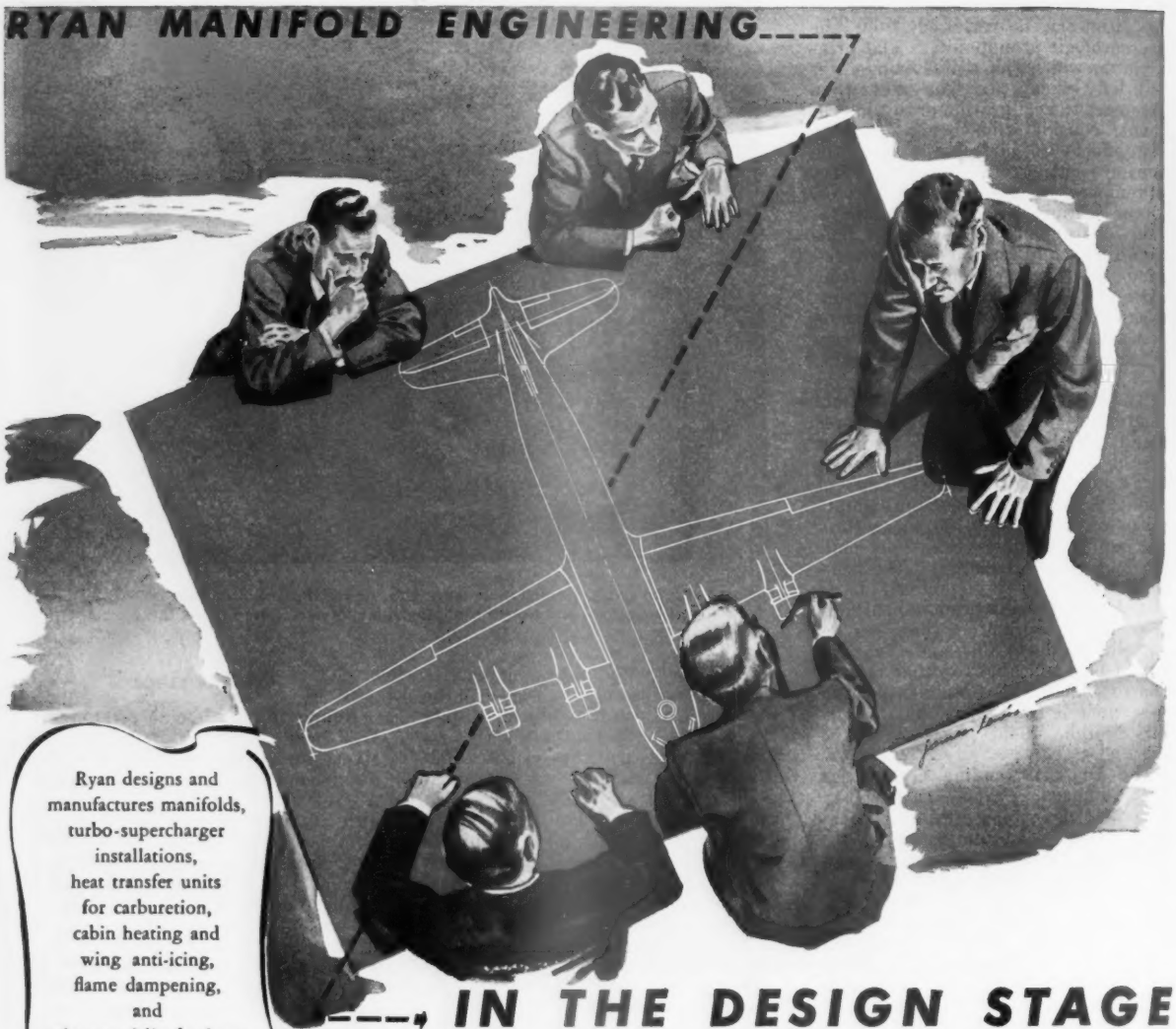
Maintenance

Rebuilding the Boeing Stratoliners. Wellwood E. Beall. Particulars are given regarding revisions and improvements that were made by Boeing Aircraft Company on Stratoliners formerly used by the Air Transport Command so as to recondition them for commercial service. The article stresses the fact that many B-17G Flying Fortress parts were adapted for use on the overhauled transports. It describes the new parts that were added to the Stratoliners, explains the structural changes required for the additions, and compares the new components with those originally used on this transport counterpart of the B-17B. As related, the reconversion included completely new wings, horizontal surfaces, engines and propellers, and landing gear. *Aviation*, March, 1945, pages 148–151, 5 illus.

Mass Production Method Speeds Black Light Inspection. Stephen L. Conomy. This article describes how Air Technical Service Command engineers developed a production-line method for the use of "black light" in the inspection of parts for rebuilt aircraft engines, which brought about the same saving in time that quantity production effects in manufacturing. It is explained that the purpose of black-light inspection is to test for open defects. An apparent drawback to the use of black-light inspection had been that it did not seem to lend itself to installation on a production-line basis. It was found that the slowing down of inspection operations could be avoided by the use of nonstop inspection procedure.

Consecutive steps in the inspection process, which starts with the immersion of the parts in a penetrant with fluorescent qualities, are de-

RYAN MANIFOLD ENGINEERING----



Ryan designs and manufactures manifolds, turbo-supercharger installations, heat transfer units for carburetion, cabin heating and wing anti-icing, flame dampening, and other specialized exhaust system applications.

----IN THE DESIGN STAGE

means lower weight, better performance

To plan the exhaust manifold system when the original design for the airplane is being made saves costly engineering time, brings reduction in weight, and results in better performance. In a typical instance a Ryan manifold design saved forty-eight pounds in the weight of a military transport plane.

By planning with Ryan during the design stage, the type of manifold system and installation best suited to your specific requirements can be readily ascertained.

Whether planning to use Ryan ball and socket type or slip-joint type manifolds, let Ryan work with you in the *design* stage. You will obtain a superior product and maximum performance, and, in wartime, *lower weight;* in peacetime, *bigger payload.*

RYAN

RELY ON RYAN TO BUILD WELL 1922-1945

Ryan Aeronautical Company, San Diego — Member, Aircraft War Production Council, Inc.

DESIGNERS AND BUILDERS OF NAVY FIGHTING PLANES AND EXHAUST MANIFOLD SYSTEMS

Air Technical Service Command Photograph

A typical result of black-light inspection of an aluminum piston. This test showed that the piston skirt and piston pin boss were cracked. Other cracks were indicated on both sides of the piston pin boss on the webs.

scribed. Photographs show defects in aircraft engine parts revealed by black-light inspection. *Aviation Maintenance*, March, 1945, pages 44, 45, 126, 130, 132, 8 illus.

"Perpetual Overhaul" Overcomes Plane Shortages. Howard D. Ingalls. Northeast Airlines' system of overhauling airplanes between scheduled daily flights is described. Necessitated by a shortage of operational aircraft, this system calls for the piece-by-piece overhaul of the plane in those hours of the day when the airplane is inoperative for the longest time. For purposes of this perpetual overhaul the aircraft is classified into 14 components and approximately 327 items. It is reported that this technique does not impair the standard of maintenance yet it permits the operator to reduce the number of aircraft in service and enables personnel to work on all phases of maintenance according to an almost unvaried time schedule. A progressive overhaul chart originated by the company for use in this "perpetual" maintenance is shown. *Aviation*, March, 1945, pages 159, 160, 163, 1 illus.

Precision Engine Rebuilding at TWA. Herb Packer. An account is given of how aircraft engines that have completed 750 hours of service are rebuilt in the TWA shops at Kansas City. The shop equipment, inspection operations, and overhaul procedure are described. *Aviation Service Magazine*, January-February, 1945, pages 10–15, 54, 12 illus.

Engine Overhaul Shop. Thomas B. Frame. The writer tells how to lay out a small overhaul depot for light-plane engines. Consideration is given to the design and location of a suitable structure to house the working area, equipment, and testing facilities. The equipment required for receiving, disassembly, cleaning, and testing, and the facilities for installing this equipment are discussed. Layout drawings and an instrumentation diagram are shown. *Aviation Maintenance*, March, 1945, pages 39–44, 98, 100, 102, 4 illus.

Tools and Traits vs. Troubles. Part II. E. L. Lindsley. Second in a series of articles examining the various phases of aircraft-engine service and overhaul is concerned with the requirements for a good aircraft-engine mechanic, the factors he encounters in detecting engine troubles, and the specific sources of these troubles. Broadly, the mechanic's "tools" are interpreted as consisting of four essentials: records and reports of the engine's performance, instrument readings, sensory perceptions, and good judgment. By means of a chart the various trouble sources in an engine and the procedure for diagnosing the failures are illustrated. The troubles are classified under operational or structural problems, general or local. *Aviation*, March, 1945, pages 164–167, 3 illus.

Management

Production Control: Scheduling. D. Tiranti. The branch of production control termed scheduling is discussed. Various definitions of the term are given. The problem of how to schedule the work through the factory most efficiently is considered. Following an outline of the initial build-up, the writer discusses batching, the issue of manufacturing orders, scheduling, the economic batch size, manufacturing orders, methods of keeping records, and other phases of the subject. *Aircraft Engineering*, February, 1945, pages 53–57, 5 illus.

Wage Incentive Methods. D. Tiranti and A. S. Pay. After a broad outline of several wage-incentive plans, one scheme is examined in detail to show how a bonus method operates and to indicate the objectives it should achieve. The methods noted are the Taylor Scientific Management plan, the Gantt and Merrick adaptations of this plan, the Halsey Premium Bonus Scheme, the Rowan Premium Bonus Scheme, the Emerson Empiric Plan; and the Bedaux Point Premium system, which is the one analyzed. With the Bedaux method, it is demonstrated how (1) the performance figures obtained daily and weekly for individuals and departments are an important and useful guide in judging labor efficiency; (2) the analysis of the losses and their cost provides management with all the facts necessary to take effective measures to deal with the losses; (3) the total cost of 1,000 units provides a means of determining the correct costs of running the department and enables management to value their departments' efficiency in terms of money. *Aircraft Production*, March, 1945, pages 146–149, 2 illus.

Engineering Department Organization Determined by Basic Functions. James E. Thompson. This is the first of a series of articles in which various phases of engineering-department operation are analyzed. The series is devoted exclusively to organization and methods applicable to the engineering departments of concerns engaged in the fabrication and assembly of parts. In this article the writer analyzes the proper setup of engineering and related departments in terms of desired functions. Typical organization charts are shown for both small and large companies, including those engaged in the manufacture of aircraft parts. *Product Engineering*, March, 1945, pages 145–151, 8 illus.

Marketing

How to Get Your Share of Export Sales. Part III. Raymond L. Hoadley. In this concluding article of a series on postwar foreign markets for American aircraft, the writer supplies answers to specific problems facing the airplane manufacturer who wishes to establish a remunerative and efficient exporting division. His advice pertains to selecting the best method of exporting, i.e., indirect exporting through experienced professional export middlemen, such as manufacturers' export agents; having a combination export manager; or, setting up an individual export organization; also, systems of banking credits; ways of assimilating knowledge of various foreign markets and their potentialities; the personnel needed for an export department; the extension of credit to foreign firms. The functions of the Export-Import Bank, created by Congress to finance and facilitate exports, are explained. *Aviation*, March, 1945, pages 116, 117.

The Power of a Woman. The value of color and attractive finishes in promoting the sales of private planes is indicated. Several illustrations emphasize "do's and don't's" in the use of finishes to make light planes more salable and advice is given as to six physical qualities fundamentally necessary for attractive and efficient finishes and color schemes. *Air Tech*, March, 1945, pages 31–34, 22 illus.

Going! Going! Gone! Tom Alexander. This article on the auctioneering of airplanes and airplane parts indicates the advantages of the service to the purchaser of aviation equipment, as well as the merits of the business for the auctioneer himself. The suggestions pertain to selection of the site where a sale is to be held; inventory of items; sequence of auctioning items; ceiling prices; and delivery. It also advises on methods to be employed in airplane auctions. *Air Pilot and Technician*, March, 1945, pages 22, 23, 31.

Materials

Water Jet Quench Improves Aluminum. Particulars are given about

the water-jet quench system adopted by the Curtiss-Wright Corporation for preventing distortion of aluminum alloys during heat-treatment. It is claimed that, in addition to preventing distortion efficiently, this scheme affords a method of safeguarding against intergranular corrosion and represents a minimum of line-up expense. The equipment consists of a housing 5 ft. wide, 14 ft. long, and 6 ft. high, and an interior studding of some 240 jets around the sides, ceiling, and bottom of the housing. Accompanying water tanks, pumps, and electrically operated conveyer tables for moving the materials from the furnace to the quench housing complete the assembly. Superiorities of this method over "fog" quench systems are indicated. *Aero Digest*, March 1, 1945, page 90, 2 illus.

Dies Made from Cerrobend for Limited Production. Kenneth C. Cathcart. A description is given of how the use of Cerrobend has solved many problems involved in making parts in small quantities at the experimental shop of the Lockheed Aircraft Corporation. It is explained that this alloy possesses physical properties that make it suitable material from which to produce hand-forming, hydraulic-press, and drawing dies; backing blocks; punches and pressure plates; power-brake joggle dies; and numerous other tools. Information is given regarding the physical properties of this alloy, methods of producing Cerrobend dies, and their uses. *Machinery*, March, 1945, pages 139–146, 12 illus.

Some Recent Developments in Engineering Materials. Parts I and II. Archibald Black. Parts I and II of a continued article give a review of important developments in engineering materials. It is explained that the article was prepared for the benefit of engineers whose work has not brought them into contact with all of the items covered.

Part I discusses developments in ferrous metals, including the National Emergency steels. Consideration is given to the composition and treatment of the alloy steels and to metallurgical advances.

Part II deals with the nonferrous metals, including aluminum, magnesium, beryllium, chromium, calcium, iridium, lithium, etc. The writer also discusses cemented carbides for metal cutting, porous chromium surfacing, die-casting materials and practices, tin and lead coatings on steel, babbitts, copper-brazing methods, laminated metals, and the "lost wax" casting of metals. Tables contain data about the properties of various metals and an extensive bibliography accompanies each of the first two parts of the article. *Mechanical Engineering*, February, 1945, pages 101–107; March, 1945, pages 190–198.

Impact Resistance vs. Hardness of Aircraft Low Alloy Steels. John M. Thompson, Jr. A description is given of tests carried out by Consolidated Vultee Aircraft Corporation to determine the relationship between the resistance to impact and the hardness of low-alloy aircraft steels. After outlining the properties of the specimens, the writer describes the routine of the tests and comments on the results. A definite relationship was established for SAE X4130, 4140, and 4340 steels on the basis of empiric data. The effects of various heat-treatments on salt-quenched and oil-quenched materials are compared. *The Iron Age*, March 8, 1945, pages 72–74, 5 illus.

Aircraft Steels and Light Alloys. W. J. Roberts. This article contains semitechnical information about the steels and light alloys used in aircraft construction. The characteristics of the three main groups of steels, that is, carbon steels, alloy steels, and stainless steels, are described. A table gives the approximate carbon content of carbon steels, their principal uses, and their characteristics. A chart shows the various sections of the iron-carbon melting and cooling range with the various working temperatures and also the points at which definite physical changes occur. Particulars about many of the light alloys used in aircraft are given in a second table. *Aeronautics*, March, 1945, pages 66, 69, 70, 72, 5 illus.

Production and Properties of Magnesium Alloy Forgings. A. L. Rustay, F. B. Rote, and C. E. Wirsing. This article is based on research work done in part under the supervision of the office of Production Research and Development of the War Production Board. Primary objectives of the project were (1) to produce and test, under static and dynamic conditions, a number of forgings from the standard forging alloys to obtain data upon which designers, particularly of aircraft components, can base design calculations in considering the application of magnesium forgings to replace heavier metals; and (2) to obtain data on the forgeability of the standard American forging alloys which will assist other forge shops in the design of proper dies and the metallurgical control of the alloys during forging.

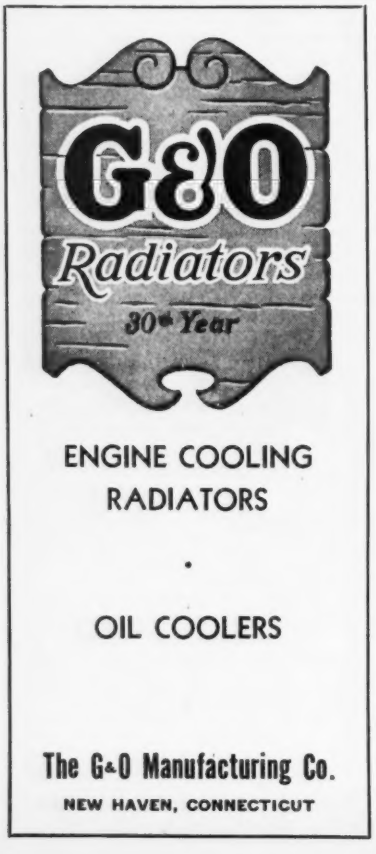
The article is concerned principally with the results obtained in experiments related to forgeability and metallurgical control. Tables give the nominal and chemical compositions of standard forging alloys, the specified and typical properties of magnesium forging alloys, and the properties of AM 58 forgings forged in dies at varying temperatures. *Metals and Alloys*, March, 1945, pages 688–694, 12 illus.

Medicine

Pressure Breathing. Lt. Col. A. P. Gagge, Capt. S. C. Allen, and Lt. J. P. Marbarger. The writers discuss pressure breathing as it is now used in the Army Air Forces. It is noted that the increasing altitude performance of newer types of military aircraft has necessitated the development of a new type of oxygen system which gives air crews flying at altitudes above 35,000 ft. greater protection against anoxia than is afforded by the conventional oxygen systems of today, such as the demand and the free-flow types.

The advantages and limitations of the pressure-breathing process are outlined. Curves present a comparison between the oxygen saturation at various altitudes while breathing pure oxygen, breathing oxygen with a 10 per cent mask leak, and using the recommended levels of pressure breathing. Details are given about the pressure system adopted by the Army Air Forces. In this system, throughout the respiratory cycle the intrapulmonary pressure is maintained at as constant a level as possible above the ambient pressure. *The Journal of Aviation Medicine*, February, 1945, pages 2–8, 4 illus.

Education of Aircrew by Medical Officers. Air Commodore J. W. Tice. The writer discusses notable contributions made by medical officers of the United States, British, and Canadian air forces during the present war which have improved the efficiency and effectiveness of members of the air crew. The medical and psychologic aspects are discussed at length. It is stated that in the



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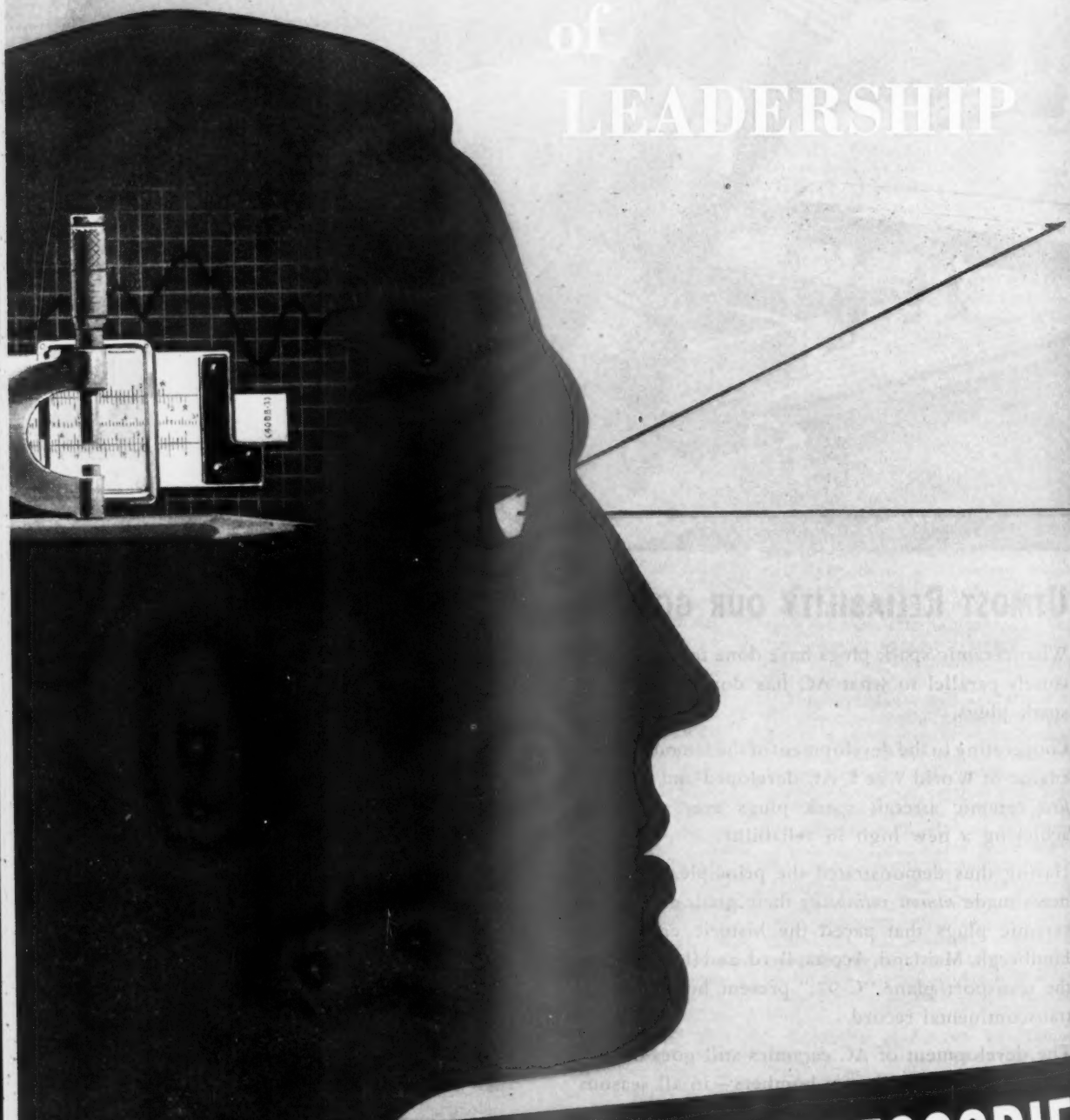

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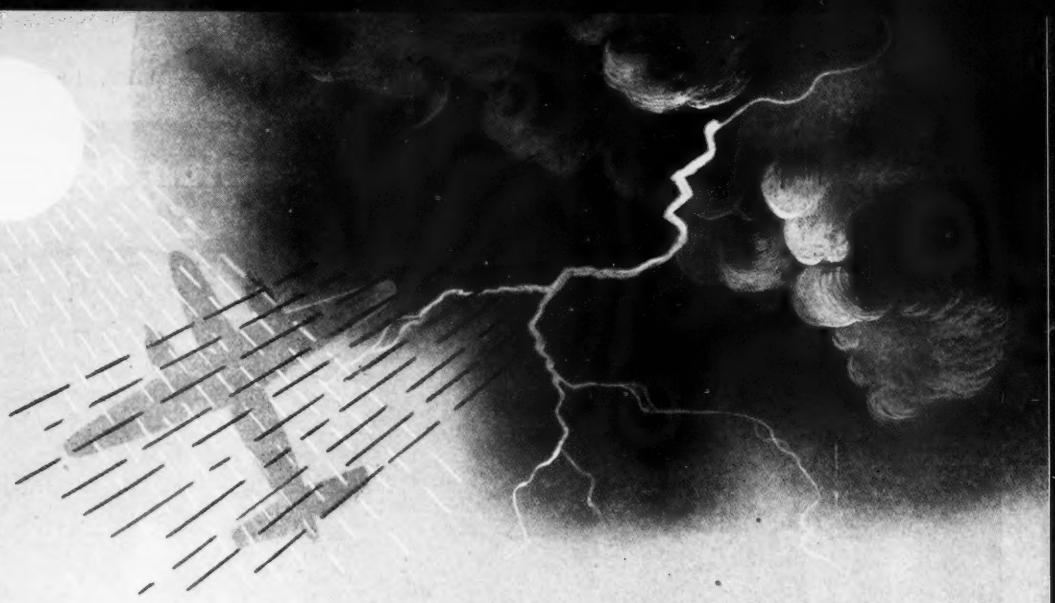

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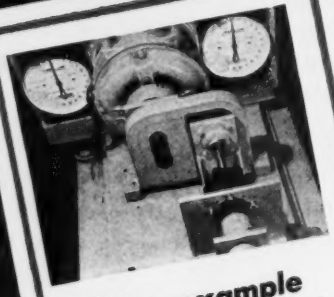
AVIATION CORPORATION

How PACIFIC-WESTERN Inspection Department serves the AVIATION INDUSTRY



*** for example**

Bombdoor actuator unit undergoing inspection department efficiency test. Each P-W actuator is thoroughly checked for efficiency, vibration, heating, grease-leakage, and must pass exacting performance standards. Besides the above production tests each prototype undergoes rigorous life, winterization and performance tests.

The final O.K.—the decision that a gear or a machine will serve you well and continuously is the responsibility of Pacific-Western Inspectors. They regularly test rough castings, forgings, and other materials for internal and external soundness—then every part is checked again after each operation such as turning, grinding, cutting and heat treating. Thus Pacific-Western Inspection Departments serve the Aviation Industry by eliminating the causes of breakdowns and failures before they reach the field—saving you time and money.

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Pacific-Western Gear make a complete line of gear reducers and actuators designed especially for the aircraft industry. Pacific-Western Actuators are available in two torque types; one type for limited rotation up to 120° at 6,000 in. lbs., another type for output speeds down to 100 rpm. at 5,000 in. lbs. torques. The jackscrew type is available with capacities to 20,000 lbs. screw load and strokes to 10 inches. Write for performance charts and technical data.

ILLUSTRATION SHOWS
Inspector in Western Gear plant checking gear shown on table for tooth form, dimension, and finish on optical comparator.

PACIFIC WESTERN
GEAR PRODUCTS

final analysis the responsibility for the effective application of aviation medicine rests with the squadron medical officer. *The Journal of Aviation Medicine*, February, 1945, pages 9–13, 25.

The National Research Council's Committee on Medical Problems of Civil Aviation. Louis B. Flexner. This is a brief report on the background and present status of the National Research Council's Committee on Medical Problems of Civil Aviation. The report, presented before the 16th annual meeting of the Aero Medical Association on September 5, 1944, outlines the work of the committee and names its members. The discussion of the report by Brig. Gen. E. G. Reinartz is appended. *The Journal of Aviation Medicine*, February, 1945, pages 14–17.

Waiver of Physical Requirements in Civilian Flying. Frank C. Kinsman. It is noted that the waiver of physical requirements is becoming a subject of increasing importance. For the benefit of examiners making such reports, the writer describes the subsequent steps taken by the Washington office of the Civil Aeronautics Administration in the disposition of a case. *The Journal of Aviation Medicine*, February, 1945, pages 18–20.

Physical Examinations and the Private Flyer. W. R. Stovall. The writer discusses a proposal of the Safety Bureau of the Civil Aeronautics Board released March 24, 1944, which would change materially the physical standards for airmen. Two suggestions are offered with respect to physical requirements for student and private pilots. One proposal would prescribe a physical examination every 2 years, to be made by any qualified physician of the pilot's own choosing. Another proposal would prescribe but one physical examination by an authorized medical examiner of the Administrator taken at the time the certificate is first issued. From this time on it would be the pilot's own responsibility not to fly if his physical condition became such that he could not pass the original examination. *The Journal of Aviation Medicine*, February, 1945, pages 21–25.

Impressions of a Field Examiner on Entering the Washington Office. Wilbur F. Smith. The writer discusses some of the problems of the medical examiner in the field. He describes how these problems are met and handled in the Washington office of the Aviation Medical Division of the Civil Aeronautics Administration. *The Journal of Aviation Medicine*, February, 1945, pages 26–31.

Medical Training at the AAF School of Applied Tactics. Col. M. S. White. This article describes how medical training is carried out at the Army Air Forces School of Applied Tactics, which functions under the A.A.F. Tactical Center in Orlando, Florida. Information is given about certain courses that have been made available to Air Forces personnel. *The Journal of Aviation Medicine*, February, 1945, pages 32–34.

A frontal view of the four 20-mm. cannon in the belly of the Northrop Black Widow P-61 night fighter.

Meteorology

The Forecasting of Fogs and Low Ceilings at Charleston Airport. A. J. Myer, Jr. It is noted that Charleston, S.C., is visited by a relatively large number of cases of fog each year, the peak months being May, September, and October. Frontal conditions are also responsible for a rather high percentage of bad weather conditions compared with other stations. Cold and warm frontal conditions in this locality are discussed. Rules are given for the prediction of prewarm frontal situations of all types. Radiation-type fogs are discussed and a graph for forecasting these fogs is shown. Curves used in the computation of the time of formation of fogs resulting from air with a maritime history also are given. *Journal of Aeronautical Meteorology*, January, 1945, pages 39–45, 3 illus.

An Investigation of the Use of Constant Level Pressure Charts for the Forecasting of Winds Aloft. Donald G. Linklater. It is noted that, as the cruising ranges and altitudes of air transports increase, the forecasting of wind aloft will become an increasingly important duty of air-line meteorologists. The changes in the upper air-pressure fields are investigated and an attempt is made to arrive at a satisfactory method of projecting constant-level pressure charts so that winds aloft may be more accurately forecast. The subject is discussed in three parts which are devoted to changes from the computed geostrophic winds; an analysis of the methods of forecasting changes in the geostrophic winds; and a trial of the conclusions reached in the second section of the article. *Journal of Aeronautical Meteorology*, January, 1945, pages 59–70, 8 illus.

Phase Relations Between Temperature and Streamline Waves. C. E. Buell. The relations between streamline and temperature waves when they are not exactly in phase or 180° out of phase are considered. The assumptions behind these considerations and the results are discussed. Diagrams for eight principal cases give some of the implications of the phase and amplitude relations that are obtained on the basis of the assumptions listed. *Journal of Aeronautical Meteorology*, January, 1945, pages 71–81, 9 illus.

Military Aviation

Tactics of Air-Ground Warfare. David C. Cooke. This is an article on the methods by which coordinated action between ground troops and air support units is obtained. Interpreting the military value of the air arm when employed in support of ground forces, it describes the three phases of air support missions, the manner in which missions originate, the selection of targets, and limiting factors in the use of aviation as a weapon against targets that impede the advance of ground forces. It explains the duties of the air support officer attached to ground troops as well as those of the army liaison officer attached to air support units.

Details are also given about how the locations of the headquarters of air and ground commanders are so ar-

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IN DEPENDABILITY

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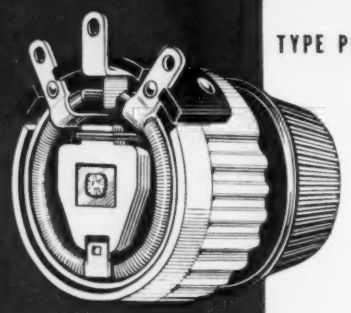

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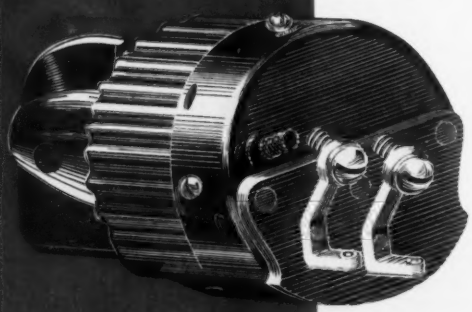

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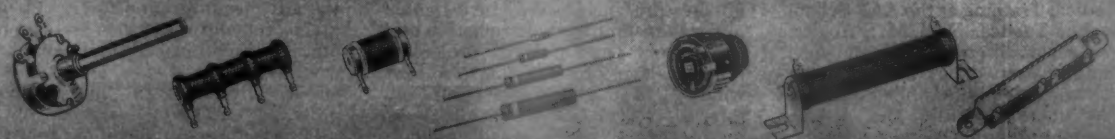


IRC makes more types of resistance units, in more shapes, for more applications than any other manufacturer in the world.

ranged that they can confer easily, how air ground operations are planned and objectives are determined. *Aero Digest*, March 15, 1945, pages 51–53, 194, 6 illus.

Naval Aviation

Report on Carriers. B. J. Hurren. Recent actions of British carrier-based planes in the Pacific zone are recorded and the trend of aircraft-carrier employment is analyzed. It is reported that aircraft carriers now constitute about half of British naval strength in that area. Noting innovations and improvements that have increased carrier efficiency, the writer calls attention to the change in numerical ratio between carriers and battleships, the extended assault power that a fleet gains through the use of aircraft, and the comparative values of escort and "fleet" carriers. He suggests the need for a new class of carrier, larger than the escort type but smaller than the 30,000-ton H.M.S. "Indefatigable." *Flight*, February 15, 1945, pages 180, 181, 183, 1 illus.

Paints and Coatings

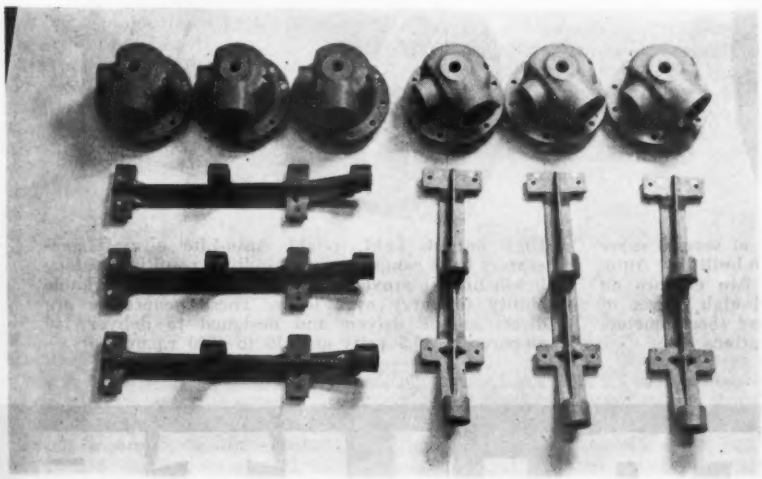
Magnesium Alloy Anodizing Process. N. H. Simpson and Paul R. Cutter. This article describes an anodizing process that permits the use of magnesium alloy in more than 400 parts of an airplane. The process was developed by Consolidated Vultee Aircraft Corporation engineers through an extensive study of experimental anodic alkaline solutions. It is stated that magnesium protected from corrosion and abrasion by this process enters into the construction of the dorsal fins, the tail casting, the trailing edge of the wing, instrument panels, pilot and navigator seats, and the general furnishings of a plane. Corrosion experiments that led to the development of the process are described. Details are given regarding the nature of the process and the advantages obtained with it. *Industrial Aviation*, March, 1945, pages 44, 46–48, 94, 4 illus.

Personnel

Features of TWA's Personnel Program. This outline is concerned mainly with TWA's system for upgrading employees. Termed "The President's Personnel Record Plan," it entails a personal interview with every worker and has as its objective the following: (1) selection of personnel for promotion; (2) selection of personnel for training; (3) assurance to all employees of full consideration for future openings; (4) selection of personnel for transfer; (5) completion of the statistical record of the company. *Aero Digest*, March 15, 1945, page 96, 1 illus.

Plant Equipment

Test Cell Lighting Problems. Davis H. Tuck. This is a detailed study of problems involved in the efficient illumination of aircraft-engine and propeller test cells. It is noted that there are two groups to be lighted, both of which must be observed by the same operator, namely, the engine in the test cell and the instruments and records in the control room. A preliminary study revealed that the control room has been overlighted and the engine has been underlighted. Causes of inefficient lighting were found to be failure to apply fundamental principles of lighting and the use of short-cut methods of making design calculations. The writer supplies specific data for use in designing test-cell lighting. *Industrial Aviation*, March, 1945, pages 64, 66–68, 95, 98, 99, 11 illus.



Some magnesium aircraft parts that have been protected from corrosion by a special process developed at the Consolidated Vultee Fort Worth Division. The darker parts on the left were anodized with direct current; those on the right were processed with alternating current.

Dodge Chicago Plant's Electric-Power-Distribution Scheme with Airplane-Engine-Testing Power Recovery. E. L. Bailey. A brief outline is given of the electric-power distribution system in the Dodge Chicago plant of the Chrysler Corporation. Particulars are furnished about the power-recovery engine-test equipment. The writer explains why slip-ring induction generators were chosen for loading the high power-output variable-speed engines. A typical test cell is described. *Electrical Engineering*, March, 1945, pages 121–123 (Transactions), 5 illus.

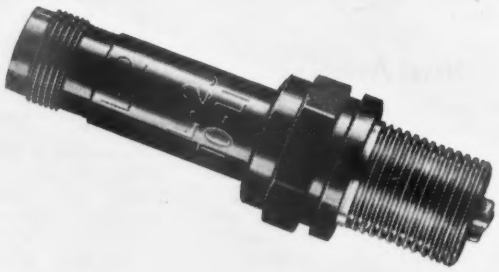
Plastics and Plywood

Maintenance of Injection Machines. The writer describes procedures that should be followed in the maintenance of injection machines. The importance of carrying out most of the maintenance recommendations of the equipment manufacturers is emphasized. It is noted that while some of these recommendations are highly theoretic, many can be followed to advantage. How many machine breakdowns can be forestalled by the use of the properly designed dies is described. Precautions that should be taken when it is necessary to overload equipment to meet war demands are outlined. A check list of general maintenance routines is provided. *Modern Plastics*, March, 1945, pages 146–148, 196, 7 illus.

Low-Pressure Laminate Plastics. Part II. George H. Tweney. Second half of a two-part article reviewing the properties, characteristics, and applications of low-pressure resins that can possibly be utilized as raw materials for the production of aircraft structural and semistructural parts. Part II contains a study of C.R. 39, a product of Columbia Chemicals Division of Pittsburgh Plate Glass Company; Laminac resin P-4122, developed by the Plastics Division of the American Cyanamid Company; and MR-1A, manufactured by the Marco Chemical Company. Summarizing the qualities of the four resins discussed in the two sections of the article, the writer states that the MR-1A resin appears to possess particular qualifications for structural applications in aircraft design planned for the use of laminated plastics. He also suggests eight factors in the application of laminated resins for aircraft design which require additional research. *Aero Digest*, March 1, 1945, pages 86–88, 203–205, 5 illus.

Steam Generator for Individual Presses. A description is given of a somewhat unusual type of electric-steam generator that has been adapted to plastic presses. The development of this generator unit for individual presses is reviewed. Information is given regarding its performance characteristics, control equipment, and operation, including the power con-

Available in both 12 volt and 24 volt types. All batteries are equipped with special non-spill vent plugs and assembled in either hard rubber or radio-shielded aluminum containers. The heavy duty battery has a capacity of 105 A.H. at 5 hr. rate; others have capacity of 34 A.H. at the 5 hr. rate.



These spark plugs feature: (1) Direct contact non-inductive resistor located in coolest position in plug; (2) Improved copper cooled center electrode; (3) Deep drawn nickel alloy center electrode tip; (4) High Dielectric strength and superior mechanical properties of "Corundum," Auto-Lite's insulator material.

Auto-Lite

EQUIPMENT FOR AIRCRAFT

On every battlefront of this war where American-built planes are flying you'll find the products of Auto-Lite's 22 great manufacturing plants. Precision-built to meet the most exacting tests, these products, some of which are shown below, are enhancing the Auto-Lite reputation for quality, craftsmanship and dependability.

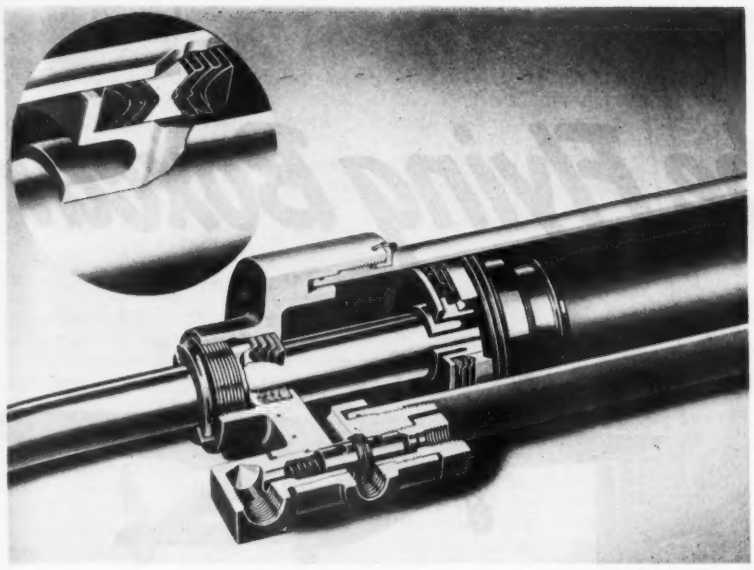
THE ELECTRIC AUTO-LITE COMPANY
TOLEDO, 1, OHIO • SARNIA, ONTARIO

This dual oil pressure gauge is one of several space and weight saving gauges precision-built by Auto-Lite. It records oil pressure from two engines on same dial, has easy readability and high degree of accuracy. Auto-Lite builds gauges and thermometers to Army-Navy Air Service specifications.

High output, light weight Auto-Lite aircraft generators have compensating windings resulting in long brush life—improved commutation and a remarkable ability to carry over loads. These generators are direct engine driven and designed to deliver 140 amperes at 28.5 volts at 2275 to 4500 r.p.m.

AUTO-LITE

TUNE IN "EVERYTHING FOR THE BOYS" STARRING DICK HAYMES—EVERY TUESDAY NIGHT—NBC NETWORK



Photograph Courtesy Hydro Pack

Illustrating the use of plastic phenolics in hydraulic equipment. This cutaway view of an actuating strut shows the use of plastic retainers.

sumption. *Modern Plastics*, March, 1945, pages 133–135, 200, 202, 3 illus.

Hot-Forming of Phenolic Laminates. H. C. Guhl. Typical applications of hot-formed phenolic laminates for aircraft are described and illustrated. Data are assembled for the guidance of the designer and user in making applications of newly developed formable phenolic laminates. Sections of the article discuss the various types of phenolic laminates, their resin characteristics, forming procedure, deep-drawing properties, and the drawing of shapes. Tables give the physical properties of laminates and a comparison of the physical properties of Micarta, woods, and metals. *Mechanical Engineering*, March, 1945, pages 175–179, 16 illus.

Phenolics in Hydraulics. E. F. Lougee. Developments in the use of plastics in aircraft hydraulic systems are discussed. The writer describes how precision-molded phenolic retainer rings, poppets, and seats for valves are now replacing those made of steel, aluminum, and bronze with considerable savings in cost and weight. Steps leading to the use of plastic retainers in place of metal retainers for holding packing material in place are reviewed. Plastic parts for hydraulic systems are illustrated. *Modern Plastics*, March, 1945, pages 103–105, 6 illus.

Analytical Aspects of Plastics. Parts II and III. Harry Barron. Parts II and III conclude an article in which means of identifying the various plastics are discussed. Part II deals with the analysis of phenolic resins. It describes the chemical constituents of these resins and various tests of the ingredients to determine the presence and extent of the different elements and compounds. Part III discusses the cellulose plastics and methods for ascertaining the contents of that class of product. Detailed instructions are given for analyzing specimens to determine whether certain substances are present and the amount or proportion contained in the specimen. Chemical formulas are applied and explained. *British Plastics*, October, 1944, pages 460–464; February, 1945, pages 56–62.

Relative Temperature Stability of Stressed Plastics. J. A. Sauer, F. A. Schwertz, and D. L. Worf. Additional comparative data are given on the temperature stability of various plastics under stress. The procedure followed in conducting the tests is described. Every effort was made to avoid or overcome the causes that give rise to discrepancies in measurements. The heat-distortion temperatures of various thermoplastic and thermosetting materials are listed. Curves show the behavior of a typical thermoplastic material under the influence of increasing temperatures. The results of the tests are discussed. *Modern Plastics*, March, 1945, pages 153–156, 192, 194, 11 illus.

Postwar Aviation

A Scottish Plan. As described in a survey published under the title "North Atlantic," the main points of a Scottish regional plan for postwar commercial aviation are outlined. The project provides for the development of British commercial aviation through the creation of operating organizations on a regional basis and advocates (1) overseas and internal air lines based on Prestwick and operated by a company native to Scotland; (2) the development of Prestwick Airport as first alternative to Heathrow, the London terminal, and as a junction for the various services through the Northern Hemisphere operated by Britain and other nations; (3) the creation of a commercial aircraft-manufacturing industry affiliated for design experience with the Prestwick commercial air lines. Data about the schedules and routes suggested for the Prestwick air line are included with other information about the proposals in the survey. Objection to Britain's "single chosen instrument" policy is stressed. *Flight*, February 22, 1945, pages 205, 206.

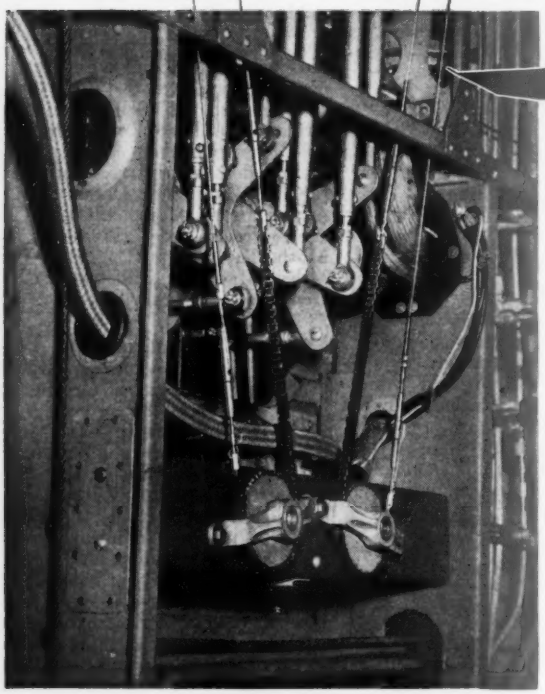
In the Shop Window. Moorhen. Amplified by a discussion of how important it is for Britain to encourage the development and manufacture of postwar civil aircraft types, this is a compendium of British-constructed airplanes of 10,000 lbs. or under suitable for private or commercial use. It includes descriptive details about the de Havilland Dominie-Rapide, Avro Anson, Airspeed Oxford, Percival Proctor, de Havilland Tiger Moth, Taylorcraft (England) Auster, Miles Magister, and others. *The Aeroplane*, February, 23, 1945, pages 228–231, 11 illus.

Postwar Australian Boost. Lloyd Clarke. A discussion of postwar intrastate aerial services for Australia. Noting the necessity for such service, the writer indicates that the required facilities can be developed from airports constructed during the war for military purposes. Two airports mentioned as certain to influence postwar internal aviation in Australia are the air depot at Tocumwal and the inland flying-boat base at Lake Boga. Statistics are given regarding mail and passengers carried by Australian civil air lines during the 5 years of war; the number of transport miles flown; airfields and airfield acreage controlled by the Civil Aviation Department; the value of such airports; and the extent of the radio-range network under the direction of the Department of Civil Aviation. *Flight*, February 8, 1945, pages 150, 151, 1 illus.

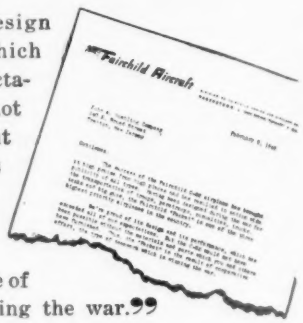
Designs for GI Joe. Vernon Payne. Airplane designs that will meet the requirements of postwar pilots are discussed. Three models are suggested, a moderate-powered two-place tandem trainer for those who must learn to fly; a three-place cabin monoplane of 235 hp. with a speed of 208 m.p.h.; and a four-place twin-engined cabin monoplane for those of more than moderate means and those doing commercial flying. The latter would be powered with two 235 hp. engines and have a speed of 260 m.p.h. The details and advantages of the three models are discussed and drawings of each are shown. *Air Trails*, April, 1945, pages 40, 41, 94, 95, 8 illus.

Our Plan for Private Flying. T. P. Wright. A program for the promotion of postwar private flying is

Inside the Flying Boxcar



Fairchild Selects ROEBLING AIRCORD



"We're proud of its design and its performance, which has exceeded all our expectations. But the C-82 would not have been possible without the materials and parts which you and others have furnished. Thus, the "Packet" is the result of cooperative effort, the type of teamwork which is winning the war."

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26,000 pounds of ship . . .
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suggested by the Civil Aeronautics Administrator. As outlined, the plan encompasses six major points: (1) an effort to meet the needs and demands of the "mass market" customer; (2) more airports; (3) simpler regulations; (4) a public training program; (5) a consumer sales program; and (6) better, cheaper planes. *Flying*, April, 1945, pages 24, 25, 123, 124, 4 illus.

Private Flying

You Can't Afford Storage. A protest against the high rates charged by the Department of Transport for the accommodation of private planes in hangars constructed by the Canadian Government and declared surplus over present R.C.A.F. requirements. The schedule of these rates is shown, with attention called to their detrimental effect upon the popularization of private flying in Canada. *Canadian Aviation*, March, 1945, page 60.

Safer Airplanes at Less Cost. G. E. Otter. The writer analyzes the airworthiness requirements imposed by various governmental authorities, particularly those which apply to light planes for the private owner, with a view toward modifications that would permit the reduction of the cost of such planes without sacrifice of safety. Noting that the cost is determined largely by the airworthiness specifications and that the potential market for private aircraft is limited by the cost factor, he describes studies made by Fleet Aircraft, Limited, to form a basis of comparison of the requirements of the American and British military and civilian airworthiness regulations. The studies were charted in such a way as to show the differences in loading and performance characteristics, and how weight and expensive construction can be eliminated. It is suggested that revisions be made in the regulations so that the standards for strength and performance can be varied to agree with the character of the service the craft will be expected to render. This would make it possible to offer safer, cheaper, lighter, and more economical airplanes for the average family use, while others for more severe classes of service would incorporate suitable characteristics for those segments of the market for which they are intended. *Aero Digest*, March 15, 1945, pages 72, 73, 203, 205, 4 illus.

Postwar Personal Planes. This compendium of aircraft that will be available for personal flying after the war includes illustrations of the various planes, descriptive data, and prices. It is supplemented by a discussion of which manufacturers intend to build such planes, when new types will appear, and likely price ranges. *Skyways*, April, 1945, pages 42, 43, 102, 1 illus.

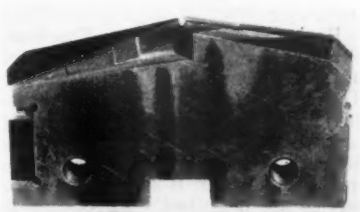
War Workers' Flying Club. Lawrence Keil. Advice for the successful conduct of flying clubs is offered from the experience of the Associated Flying Clubs of America, Inc., a group of clubs formed among the personnel of several war plants. The information includes data pertaining to the costs to the individual; equipment; membership; direction and supervision of the club; rules of conduct for members; costs of operation; insurance; selection of airport and operator; and allotment of flight time. Advantages of combining several clubs are noted. *Flying*, April, 1945, pages 26, 27, 118, 120, 5 illus.

Production

Aircraft Breakdown for Increased Production. A. H. Petersen. The writer discusses the most efficient methods of planning a manufacturing breakdown for war production of airplanes. Factors a designer must consider when he is given a preliminary design and a set of customer's specifications are analyzed. It is noted that breakdown will vary with the size of the aircraft and with the manufacturing conditions under which it is to be built. Steps are indicated for the coordination of functional design with feasible production methods.

The establishment of the first breakdown, after the basic design is determined, is discussed. Assembly methods for efficient production are described. Charts show a design organization based on manufacturing breakdown; the organization of a functional design group; and how assembly sequences may be planned when design is broken down with production in mind. *Industrial Aviation*, March, 1945, pages 57, 58, 60, 62, 63, 100, 101, 13 illus.

Spinning Aluminum. E. H. Benson. Reference is made to the expansion in the use of spun metal products since the introduction of aluminum to the spinning industry. It is noted that spinning is now used extensively for the production of parts made of aluminum. The advantages of the spinning process as applied to the manufacture of aluminum parts of various shapes are outlined. The methods, techniques, and tools used in the spinning of aluminum are described. *Aluminum and Magnesium*, February, 1945, pages 28, 29, 36, 37, 2 illus.



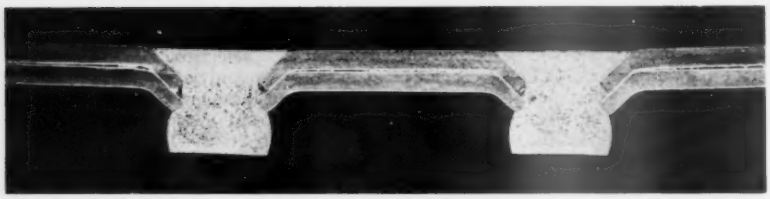
To overcome difficulties experienced at the Curtiss-Wright Columbus plant in drilling large deep holes in landing-gear hydraulic cylinders, a modified design of spade drill was found to provide increased production speed and longer life between grinds. This photograph shows a modified drill with inserted carbide cutting edges. The most notable features of the new design are the slot through the dead center and the greatly increased point angle. The bevel on the outer edge helps to center the drill and strengthens the outer edge of the lips.

Formed Sheet Metal Parts Classified by Shape. Part I. Mark P. Meinel. In the first of a series of articles, the writer discusses the classification of formed sheet-metal parts for aircraft. Formed sheet-metal parts, particularly of aluminum alloys, are classified by finished shapes in relation to the factors in design that should be considered for simplest production methods, and according to the various production methods and machines that are in use. Six types of formed parts are listed in a table. Design factors for Type 1 curved parts and Type 2 curved sections are discussed in this article. *Product Engineering*, March, 1945, pages 167–171, 9 illus.

Technique for Heat Treating 18-8 Stainless Steel. Keith Whitcomb. A description is given of a new salt-bath treatment for stainless steel, developed by Ryan Aeronautical Company, which is stated to have proved faster and more economical than the method formerly used. The procedure followed in the treatment of stainless steel exhaust manifolds is outlined. Experiments with various salt solutions for the heat-treatment of steels are described. The advantages of the new salt-bath method are set forth. *Industrial Aviation*, March, 1945, pages 38, 39, 42, 43, 94, 4 illus.

Machining Magnesium. A. M. Lennie. The writer undertakes to bring together some of the extensive accumulation of knowledge about the working characteristics of magnesium which has resulted from the recent great expansion of the magnesium industry. The article summarizes information that has been obtained in magnesium machine shops, in the machineability laboratory, and from service problems that have arisen in industry. The machining characteristics of magnesium are discussed in detail and the relative amounts of power required to machine various metals are listed. Attention is given to the tools that are most suitable for machining magnesium.

Tables give the properties of the cutting fluids recommended for machining magnesium, and recommended speeds, feeds, and depths of cut for turning, boring, and milling magnesium. Precautions that should be taken when machining magnesium



Ryan Aeronautical Company's dimpling process produces strong, well-formed dimples in high-strength aluminum alloys without radial or circumferential fractures. The cutaway section shows flush-type rivets up set in 0.051 in. high-strength alloys. The perfect nesting of the rivet head in the dimpled area and the flush position of the rivet head are clearly evident.

are discussed. *Aluminum and Magnesium*, February, 1945, pages 17–21, 30, 31, 8 illus.

Manufacturing the Hercules Piston. Part I. J. A. Oates. Beginning of a two-part article describing the methods by which Specialloid, Ltd., manufactures pistons for the 14-cylinder Bristol Hercules sleeve-valve engine. These methods feature the hydraulic deep-pressing technique for the production of blanks. Part I tells of the stamping, press-forging, and machining operations employed. It directs attention to the unusual fabrication problems caused by the eleven internal and external recesses or pockets provided in the design. Included with the many illustrations is a table listing the sequence of operations for the piston's manufacture. *Aircraft Production*, March, 1945, pages 128–139, 47 illus.

Determining Bend Radius—via Analytical Approach. George Gerard. A detailed explanation is given of a method for determining minimum bend radii for use in forming sheet-metal structures. The problem is stated, the test specimens are described, and the bend is analyzed. A nomographic chart is constructed from which the calculations can be performed rapidly. Results obtained by the method are discussed. *Aviation*, March, 1945, pages 152–155, 6 illus.

Modified Drill Design Increases Tool Life and Production Rate. Roy W. Parkinson. This article describes the methods adopted to overcome difficulties experienced at the Curtiss-Wright Corporation's Columbus plant in drilling large deep holes in landing-gear hydraulic cylinders. A modified design of spade drill was found to provide increased production speed and longer life between the grinds. *Machinery*, March, 1945, pages 156–161, 10 illus.

Avro York. Wilfred E. Goff. A review of the procedures and fixtures employed in the production of the first British wartime transport aircraft. Since standard Lancaster components are used for the outer wing panels, tail unit (with the addition of a central fin), and undercarriage of the York, this article is concerned principally with the manufacture of the York's fuselage. It gives details about the fabrication, assembly, and design of the plane's nose section, forward and rear center sections, intermediate center sections, fuselage tail section, central fin, and servicing facilities. In addition to numerous illustrations, the article is supplemented by general descriptive data and figures showing the dimensions, weights, and performance of the York. *Aircraft Production*, March, 1945, pages 109–121, 33 illus.

Propellers

The Stalling of Airscrew Blades. V. D. Naylor. Reference is made to a previous article by the writer in which some remarks were made about the stalling of propeller blades and some of the effects of stalling. The writer then presents a more detailed study of the kinematics of stalling. *Aircraft Engineering*, February, 1945, pages 48–50, 8 illus.

Reaction Propulsion

The Turbo-Jet. M. N. Golovine. The writer reviews early developments in recoil drives, including rockets, resonance reaction drives, and gas turbines and jets. The principles involved in the various forms of jet propulsion are discussed. Mechanical-compression jets are classified. A theoretic comparison is made between two geometrically similar aircraft, one equipped with piston engines and the other with jet units. *Aeronautics*, March, 1945, pages 24–28, 7 illus.

Research

Research Guarantees Freedom. Brig. Gen. F. O. Carroll. The Chief of the Engineering Division of the Air Technical Service Command discusses the research work that is being carried out by the Army Air Forces. Some of the problems that had to be solved before the B-29 was put into service are described. An outline is given of how high-altitude flight problems connected with the maintenance of satisfactory engine output, the insulation of ignition cables, and cabin pressurization were solved through research. The development of automatic navigation equipment for the B-29 is discussed briefly. *SAE Journal*, March, 1945, pages 17–19, 5 illus.

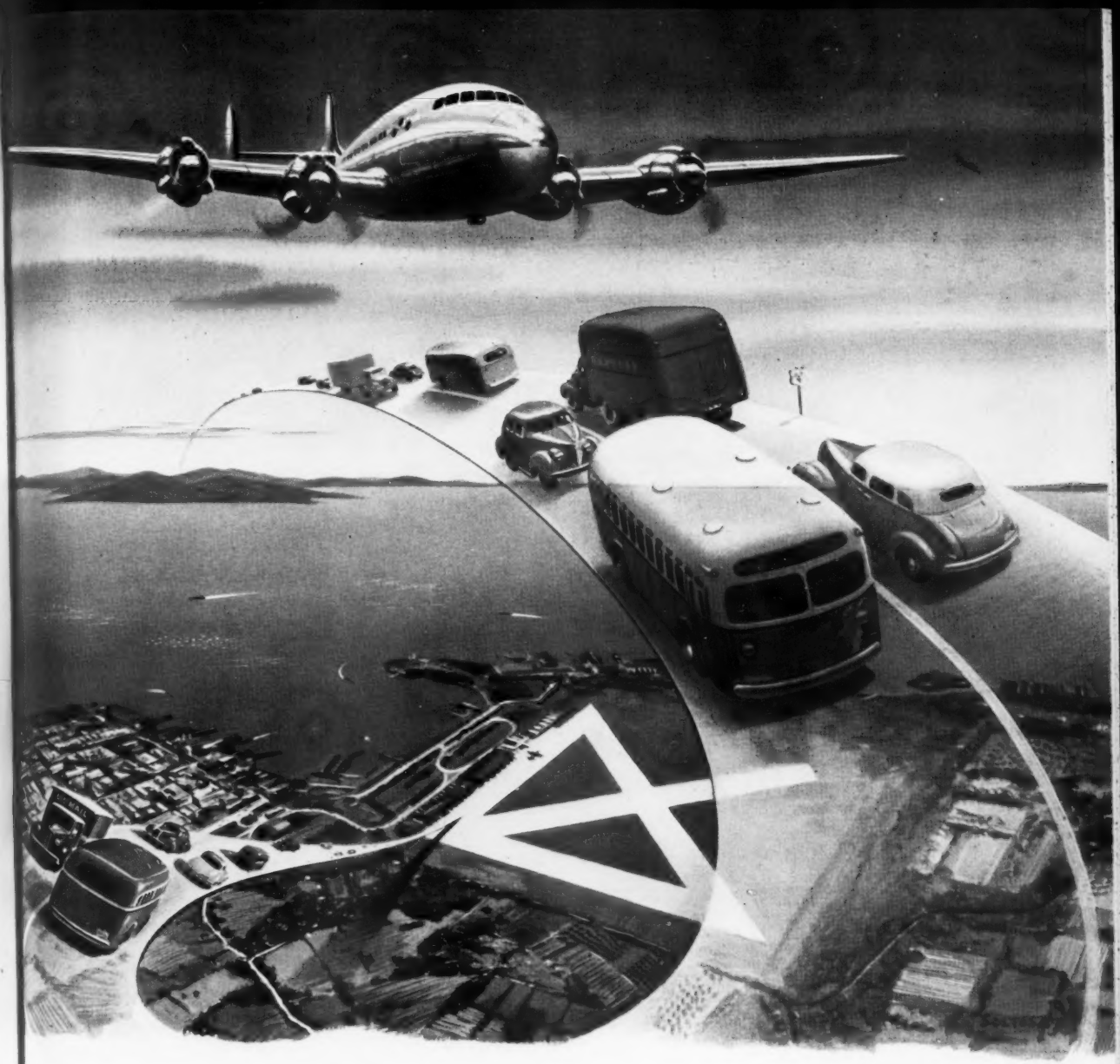
How May We Simplify the Postwar Laboratory? Part III. K. R. Jackman. Third article in a series analyzing the meanings, values, and problems of research as they relate to the aircraft industry is concerned with methods of organizing research work for industrial aviation purposes and with conditions under which such work should be conducted. Staff functions of a laboratory and its basic components are discussed. The application of four elemental types of organization to the research laboratory is considered, with emphasis placed on the unfeasibility of applying quantity-production methods to the creative work of the laboratory technician. Seven principal types of organized research laboratories in existence are classified and examples of each are given. Comparative merits of the "departmental" and "cell" system of organization for research units are investigated. Throughout the article the viewpoints of various authorities on the subject are quoted and a bibliography is appended. Three charts illustrate the major staff functions of an industrial laboratory, the organizational place of the laboratory in an automobile company's engineering setup, and the importance of practical laboratory and field tests in the work flow of a typical automotive division. *Aviation*, March, 1945, pages 143–147, 4 illus.

Rotating Wing Aircraft

Principles of the Helicopter. Part IV. Alexander Klemin. This fourth and concluding article of a series on helicopter construction and operation completes a discussion, begun in Part III, of five helicopter designs that were submitted in a competition held at the Daniel Guggenheim School of Aeronautics, New York University. The entries of the third, fourth, and fifth teams of contestants are examined in detail. Pertinent conclusions based on these five designs are offered regarding fundamental factors affecting the design development of helicopters. *Aero Digest*, March 1, 1945, pages 81–85, 255, 6 illus.

Stress Analysis

Coefficient Method for Solving the Flutter Frequency Equation. M. V. Barton. The flutter frequency equation for a three-degree-of-freedom system is a cubic equation with complex coefficients. The usual methods of solving this equation involve the solution of a cubic equation for every assumed value of the "reduced velocity." The coefficient method makes it possible to determine the stability of the motion from the relations of the coefficients of the frequency equation and eliminates the necessity of solving any cubic equation to determine the critical conditions. The method also makes it possible to obtain a "bracket" of the critical conditions, thereby reducing



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From its first chugging start, the automobile had inherent utility. But it took forty *billion* dollars, spent to build 3,038,000 miles of highways, roads and streets, to extract the vehicle's full use.

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Lower air fares and cargo rates in the future will increase the value of such air transport to each city and nation. Reduced rates will result both from traffic gains and new equipment. Wright Aeronautical is helping to make such rates a reality by constant improvements in aircraft engines, by building engines that pay their way in use.

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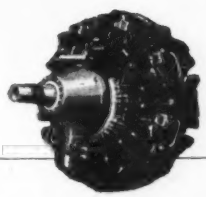

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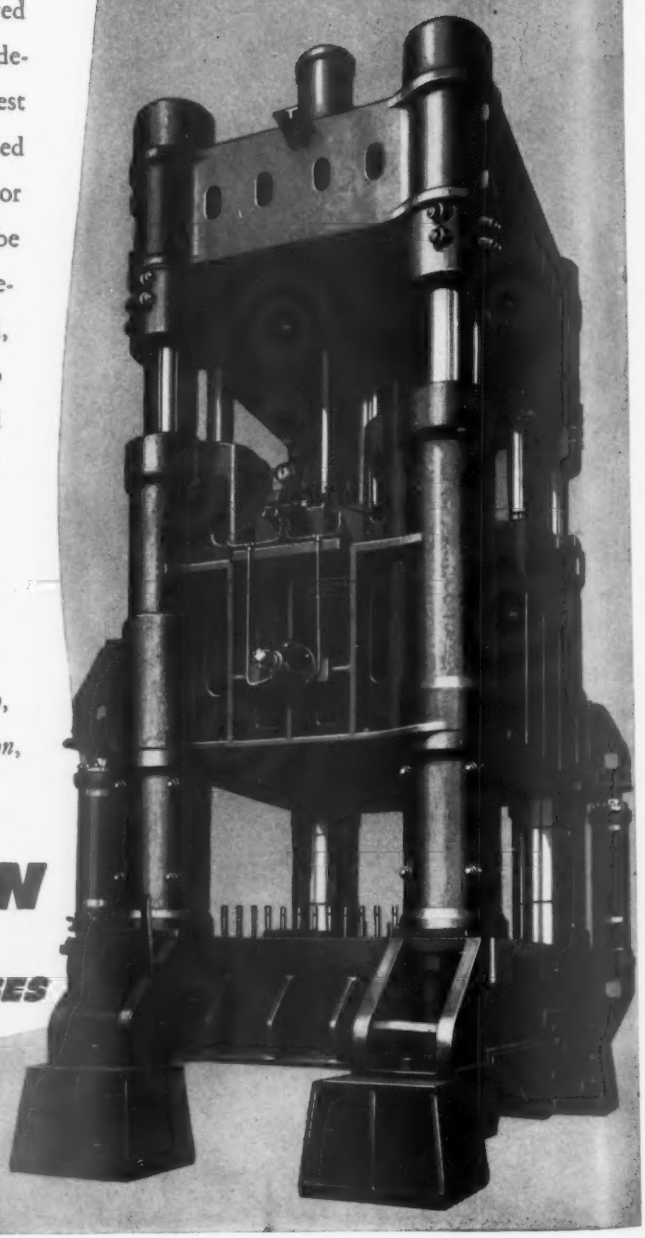

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HYDRAULIC PRESSES

the number of trial values of the reduced velocity. The intersection of the curves indicating the critical conditions is, in general, more definitely established by the coefficient method than by other methods. The method may be easily extended to systems with more than three degrees of freedom. *Journal of the Aeronautical Sciences*, April, 1945, pages 164–168, 6 illus.

Measurement of Maneuvering Loads in Flight. C. J. Buzzetti and W. L. Howland. This paper describes some of the work done at Lockheed Aircraft Corporation in the technique of making stress measurements in flight, with particular reference to the measurement of maneuvering stress, which is defined as that increment in stress which is caused by, or entirely dependent upon, the maneuver being made. Wire resistance-type strain gages were used to measure boom and fuselage bending moments, wing stresses, stabilizer stresses, accelerations, control forces, control-surface hinge moments, and surface positions during the tests to ascertain maneuvering loads. The instruments used in tests conducted in a P-38 and a Constellation are described, as well as the methods followed in the tests. Among the stresses measured in a series of roll tests of the P-38 were stresses in four members of the right engine mount and support bay; shear stresses in the rear shear beam and in the upper surface of the wing near the main beam (outboard nacelle); spanwise bending stresses in the upper surface of the wing at the main beam, just outboard of the nacelle; pilot effort in terms of aileron control-wheel moment; vertical (normal to the spanwise axis) accelerations at each engine mount and at the nose of the airplane.

Details are also given about measurements made during pull-outs to determine what the maneuvering increment of tail load on a P-38 would be during a pull-out from a dive. It is concluded that, in general, the maneuvering loads resulting from sudden control surface deflections show that they are as much or more a function of the rate of applications of control force as of the air speed. Maneuvering tail loads obtained in flight on both the P-38 and the Constellation show that during sudden pull-ups the loads produced are small as compared to those used in design. *Journal of the Aeronautical Sciences*, April, 1945, pages 195–202, 11 illus.

Stress Analysis of Nondevelopable Semimonocoque Structures Considered as Beams of Variable Section. Leon Beskin. The purpose of this paper is to present a rational, although approximate, method of analysis of structures constituted by a shell of elongated shape, reinforced by frames.

Conventionally, beam formulas are applied to such shells and define axial stresses. Shearing stresses are computed, either applying shear distribution formulas for beams—in which case, the shearing forces and torques are corrected by the so-called "shearing components of the axial forces"—or, more accurately, considering shear forces as equal to the variations of axial loads between consecutive sections, summed along the circumference of the shell. Shear centers are determined in the same manner as in cylinders. Stress distributions obtained in that manner do not fulfill the conditions of equilibrium and the conditions of compatibility of deformation.

In the case of elongated closed shells with a small taper, the errors introduced by these approximate methods can be neglected for practical purposes, although the equilibrium of frames, resulting from the shear distribution, may prove unsatisfactory. When the taper of a shell is large, this taper being roughly defined as the difference of average cross dimensions at two sections, divided by their distance, and especially when open shells are considered, the error may be as high as 100 per cent. Such large errors generally result from incorrect distributions in torsion bending which are not in equilibrium with the applied loads.

In view of the inaccurate results obtained by conventional methods, the writer offers a revised method in which the influence of shear, of the local distribution of loads, and of the flexibility of the frames are disregarded. For that reason the method is considered as approximate. In many cases, however, the results are not less accurate than for cylindric shells, for which the above-mentioned effects exist, with the exception of the influence of shear, which does not affect normal stresses at great distance of points of load application.

When the differences between a cylindric shell and a noncylindric elongated shell are examined, they can be reduced to three main factors: the taper, defined as indicated above; the twist, i.e., the effect of the nonsimilar shape of consecutive cross sections; and the curvature of the shell in the direction of its great dimension.

The effect of the taper has been investigated, in relationship with the equilibrium of developable surfaces, in a previous paper by the writer, and its physical significance is not examined in this paper. The effect of the curvature is disregarded, because it is assumed to be small in the types of shells under consideration. Thus, the main object of this paper is the study of the effect of the twist and of the combined effects of twist and taper. *Journal of the Aeronautical Sciences*, April, 1945, pages 203–216, 14 illus.

Stresses in a Ring Loaded Normal to Its Plane. E. R. Walters. General equations are developed for the internal forces in a closed plane ring or frame loaded perpendicular to its plane. The equilibrium condition is determined in the ordinary manner by minimizing the strain energy with respect to bending, torsion, and shear at an imaginary cut. Parameters required for numerical solution of problems may indicate a method similar to the "column analogy" for rings loaded in their plane.

Formulas and charts are given in an appendix for a circular ring of constant cross section with a point load and reaction distributed as the axial stress in a cylinder. The internal forces are given immediately by coefficients read from the charts. Any set of point loads may be built up by superposition of single loads, and the distributed reaction disappears if the applied loads are self-equilibrating. *Journal of the Aeronautical Sciences*, April, 1945, pages 235–240, 4 illus.

Rings for Two-Decked Fuselages. Leon Beskin. A method of analysis is presented for frames of a two-decked airplane, or more generally, for doubly connected symmetric frames. The method avoids the solution of simultaneous equations for the determination of the redundant unknowns, the latter being chosen in such manner that they are given independently of one another by relatively simple expressions. *Aircraft Engineering*, February, 1945, pages 39, 40, 50, 7 illus.

An X-Ray Diffraction Study of the Fatigue in Metals at High Stresses. Arthur G. Barkow. A report is made of an X-ray diffraction study of the fatigues occurring in aluminum-alloy machine parts subjected to high stresses. The materials and apparatus used are described. Fourteen specimens of 14ST aluminum alloy were studied at various cycles and stresses. The results of six of these studies are discussed in detail and photographs of the diffraction patterns are shown. The results of the investigation are summarized. *Journal of Applied Physics*, February, 1945, pages 111–120, 7 illus.

Redundant Pin-Jointed Frames. H. E. Vincent. A method is presented for use in the solving of any redundant frame problem under any conditions of loading. Five tables are provided and explained. It is shown that they are adapted to the particular needs of any problem and should enable an accurate solution to be obtained without difficulty. *Aircraft Engineering*, January, 1945, pages 14, 15, 1 illus.

Analyzing the Strength of Curved Beams. Part II. O. A. Carnahan. The second and concluding part of an article on the analysis of stresses in curved beams. The writer explains how previously derived equations for tangential, radial, shearing, and combined stresses may be applied to the design of a curved beam member. *Machine Design*, March, 1945, pages 147–149, 5 illus.

A Suggested New Parameter for Fatigue Strength Analysis. Victor Seliger. The writer suggests a new parameter for use in the presentation of fatigue-strength properties and in

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the analytic development of fatigue-strength theory. Its advantages and possible limitations are discussed in the light of presently available data. The need for more developments such as this is emphasized. In an appendix a short discussion is given of the concept of the effective stress-concentration factor in fatigue. *ASTM Bulletin*, January, 1945, pages 29–32, 7 illus.

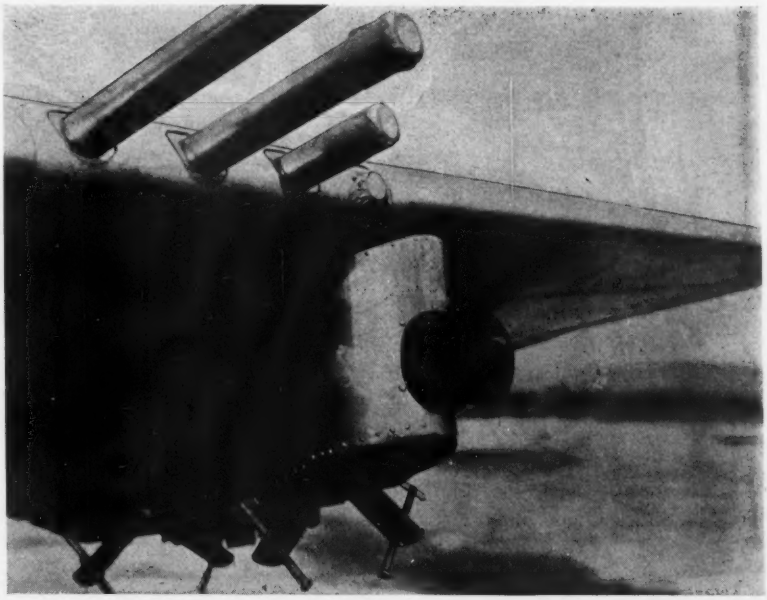
The Failure of Struts. A. N. Kinkead. This is a theoretic examination of the subject, with reference to various materials and sections. It is noted that in structural design engineers are very often faced with the problem of a strut of some particular constant cross section with partially fixed or free pin-jointed end conditions and in which the line of action of the applied load does not coincide with the neutral axis of the strut Reference is made to several approximate formulas that may be used in the analytic determination of the crippling load. It is stated that the most common formula in every day use for pin-jointed end conditions is the Modified Euler Theory for Eccentric Loading, but this formula is difficult to use. The need in design work today for a formula that will give the crippling load directly for such cases led to the evolution by the writer of a formula, the proof of which is given. *Aircraft Engineering*, January, 1945, pages 3–7, 20, 6 illus.

Superchargers

Cooling Hood for Turbosupercharger. Particulars are given about a cooling hood for a turbosupercharger developed by an engineer of the Consolidated Vultee Aircraft Corporation. This hood functions primarily as a cooling unit for the turbine section and is stated to improve the performance of the engine and airplane. The hood provides a cooling cap of the radiation type on the under side of the turbine wheel. It also provides a duct that connects the exhaust gases from the buckets or vanes of the turbine wheel to the open air so as to create a jet, thus eliminating exhaust drag and increasing the speed of the airplane. *Automotive and Aviation Industries*, March 1, 1945, page 37, 1 illus.

Testing

Parts Fixed by Buyer to Avoid Assembly Delays. Charles A. Shattuck. This article describes how the Chance Vought Aircraft Division of United Aircraft Corporation tests and repairs hydraulic units and Government-furnished equipment in order to minimize delays and returns to suppliers. Testing and repair work is carried out in a laboratory especially established for the purpose. Illustrations show testing and repair operations and equipment. *Wings*, March, 1945, pages 1455–1457, 8 illus.



A Fairchild K-25 automatic camera, mounted in a special bracket fixed to the jack pad and the bomb-shackle-sway brace, enables fighter airplanes engaged in air-and-ground coordination operations to photograph their own strikes. The camera is operated by a push-button control from the cockpit and exposes 50 4- by 5-in. negatives in approximately 21 sec.

Tools and Equipment

High-Speed Band Sawing. H. J. Chamberland. The construction, operation, applications, and advantages of mechanized contour-sawing equipment with speed ranges of from 1,500 to 10,000 ft. per min. are described. Recommendations are made regarding the techniques and best velocities for using these machines when sawing different types of materials. Two tables supplement the text, one lists saw velocities and pitches for various steels and cast irons; the other, woods, plywoods, alloys, and miscellaneous materials. *Aero Digest*, March 1, 1945, pages 114, 116, 118, 5 illus.

Training

Aviation: Its Place in Tomorrow's Curriculum. Ray Evans, Jr., and Eleanor M. Johnson. Aviation education in the junior and senior high schools is discussed. It is stated that the wartime importance of preflight aeronautics and the consequent stress placed thereon are not criteria for determining the place of aviation education in tomorrow's curriculum. The potential values of aviation education in American schools are considered. *Education*, March, 1945, pages 442–444.

Welding

Summary of Observations of Cracking in Spot Welds in Alclad 24S-T. Robert A. Wyant. This is a summary of information about cracking in spot welds in Alclad 24S-T which has been obtained through aircraft spot-welding research conducted at the Rensselaer Polytechnic Institute. Sections are devoted to: the cause of cracks, the conditions for cracking, the detection of cracks, the effects of cracks in spot welds, how to avoid cracks, and the susceptibility of other alloys to cracking. *The Welding Journal*, March, 1945, pages 183-s–185-s.

Shear Strength of Copper Brazed Joints. N. L. King. The results of shear tests on copper-brazed joints are tabulated and discussed. The investigation was conducted by Consolidated Vultee Aircraft Corporation to determine whether or not the degree of surface finish of the brazing interfaces has any influence on the resulting joint. Descriptions are given of the specimens tested and the methods followed. *The Iron Age*, March 8, 1945, page 71, 1 illus.

Gas-Shielded Arc Welding. Recent developments in the atomic-hydrogen, argon-shielded, and helium-shielded processes for welding stainless steel and light alloys are surveyed. Details are given regarding the techniques and equipment used in these processes and the materials for which each is particularly adapted. Their advantages and limitations, applications to aircraft, comparison with oxy-acetylene welding, and costs are considered. *Aircraft Production*, March, 1945, pages 122–125.

Spot Weld Characteristics of Heavy Gages of 24ST Alclad Aluminum Alloy. M. L. Ochieano. The investigation reported was conducted by Lockheed Aircraft Corporation for the purpose of determining the character-

istics of spot welds made on a double-impulse d.c. welder developed by the company. Tests were conducted to determine shear and tension strengths and consistency on 0.091, 0.102, and 0.125 24ST Alclad. The program was expanded to include 0.156 24ST Alclad. Tests were conducted on shear strength specimens only. The test procedure is described and the results of the investigation are summarized and discussed. The conclusions reached are listed and certain recommendations are appended. *The Welding Journal*, March, 1945, pages 157-s—166-s, 24 illus.

Uniform Welding Procedure. The value of a procedure-control system of welding is indicated, and various factors in the installation and operation of such a system are discussed. Salient points that are taken into consideration include proper training of the individual operator; determination of welding requirements for specific jobs; inspection routines; designing and building of proper welding jigs; selection of the most efficient type of welding machine. Three types of welds ordinarily used in fabrication plants and welding shops are described, the forehand ripple weld, the backhand weld, and the "scale" weld. In differentiating between a.c. and d.c. types of welding machines, certain advantages attributed to the a.c. welder are cited. *Aero Digest*, March 15, 1945, pages 98, 196, 199, 3 illus.

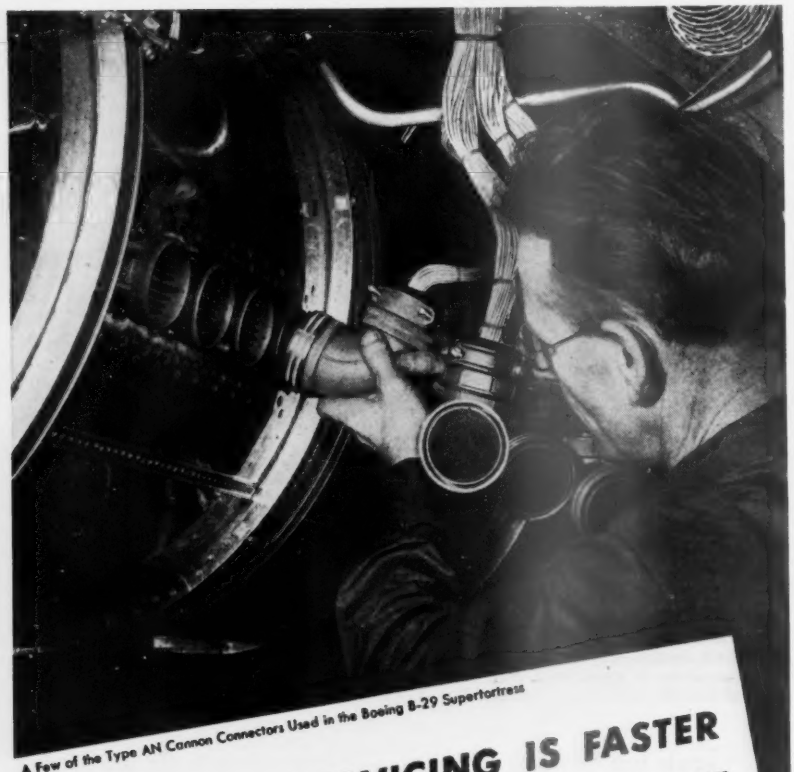
Brazing Speeds Aircraft Construction. A brief article discusses applications of brazing in the assembly of airplane parts. A table gives some of the most important applications of brazing in airplane construction, together with data describing some of the details of the particular jobs. *The Iron Age*, March 15, 1945, pages 66–68, 9 illus.

Miscellaneous

Annual Statistical Issue. In the current issue sections are allotted to data on the cost of global warfare, general industrial and lend-lease statistics, statistical data about the automotive and aviation industries, and specifications. The aviation section includes figures on aircraft acceptances, airplane weights, airplane and engine production, exports, air-line operations, airports, and other subjects. Tables give the specifications of military aircraft; aircraft engines; gasoline, Diesel and heavy-oil engines; and small gasoline power units. *Automotive and Aviation Industries*, March 15, 1945, pages 33–84.

Aircraft Designation Systems. An explanation is given of the aircraft designation systems of three countries, the United States, Great Britain, and Germany. The significance of numerical and alphabetic symbols indicating changes in design or equipment is outlined and examples are noted. *The Aeroplane*, February 16, 1945, page 199, 2 illus.

(*Continued on page 161*)



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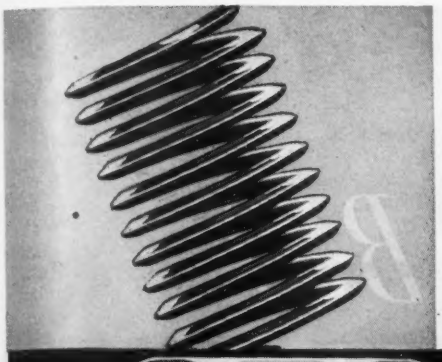
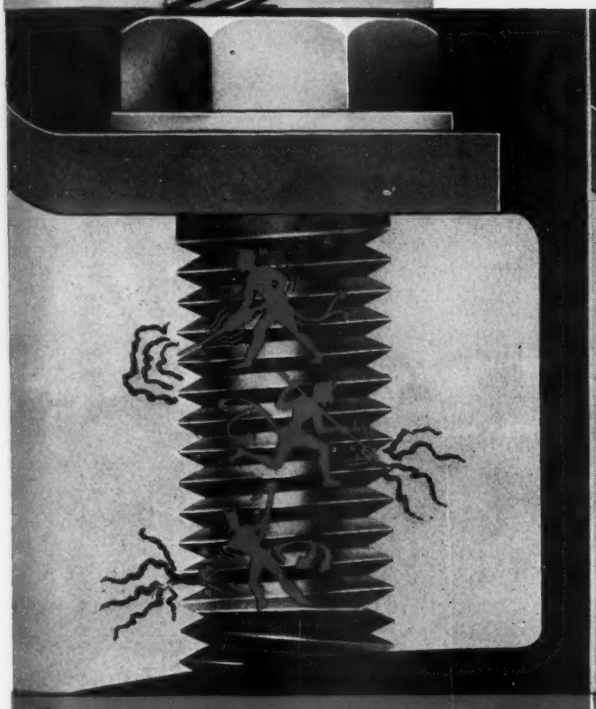
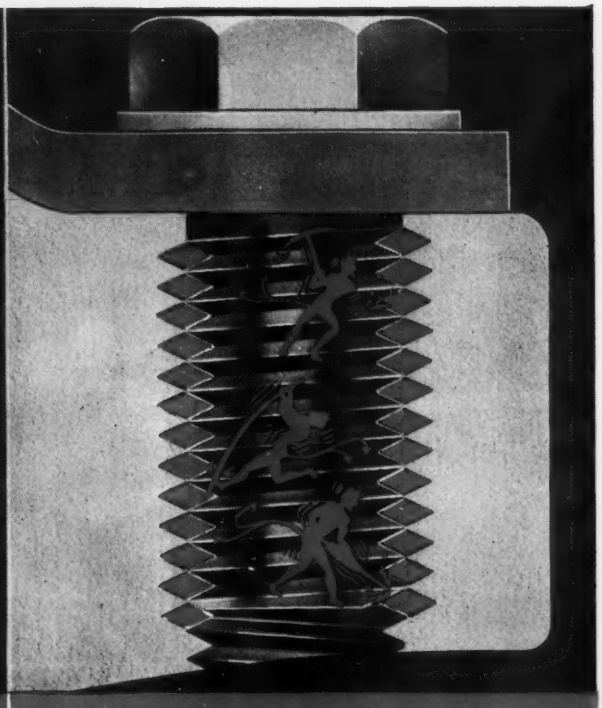


Heli-Coil INSERTS PUT STEEL ARMOR ON LIGHT METAL THREADS!



An unprotected light-metal tapped thread is subject to wear and abrasion through vibration of the steel holding screw or stud—or friction caused by its removal and replacement.



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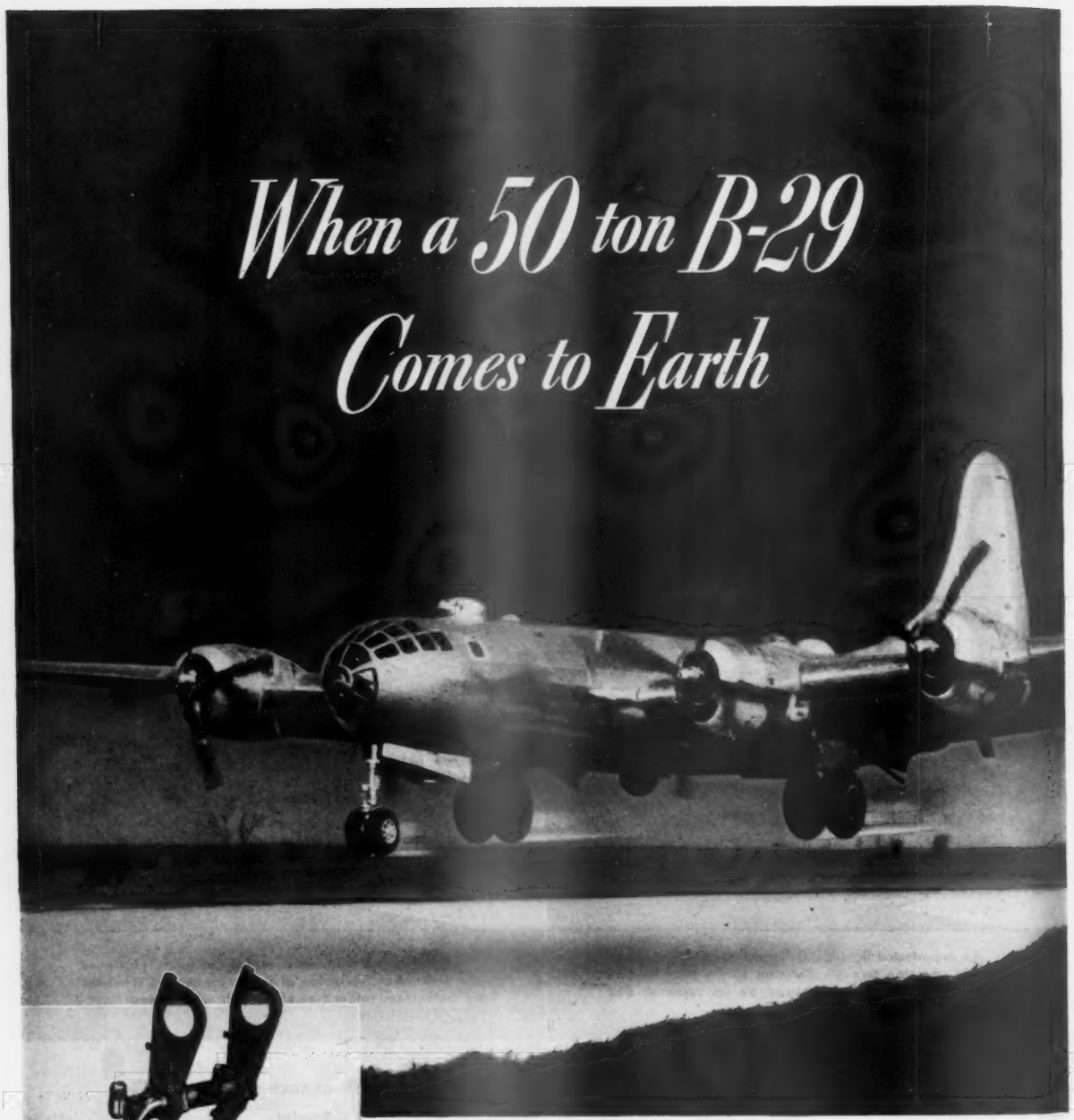

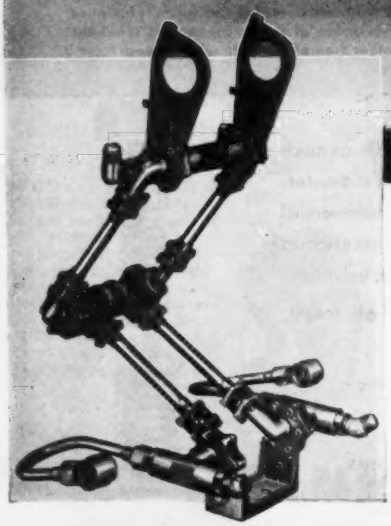

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Government Publications

Army Air Forces

Second Report of the Commanding General of the Army Air Forces to the Secretary of War. In this summary of the activities of the Army Air Forces as submitted to the Secretary of War and to the American people, General Arnold reviews the progress of aerial combat in the principal theaters of operation and gives briefly a report of the advance in research, development, and warfare.

It is a narrative that endeavors to explain, through illustrative or typical activities, the course of the war as affected by aircraft, to evaluate what has been achieved, and to outline the role played by the A.A.F. in cooperation with other forces.

In conclusion, the lessons that the war has taught regarding air power and our national security are outlined. The report is well illustrated, showing the devastating effect of bombings of many kinds of targets. Charts and tables give statistics concerning the operations of the A.A.F. *War Department Bureau of Public Relations,* Washington, D.C., February, 1945.

Celestial's Future. Three connected articles refer to the study and practical application of the principles of celestial navigation. The first article titled "The Sky's the Limit," by Walter S. Houston, gives a brief review of the older methods of celestial navigation and discusses the new methods, instruments, and processes that have been developed to make the work of the navigator easier and more accurate. It outlines the advantages and disadvantages of conventional methods of celestial navigation by comparison with the newer methods. Although the merits of the new methods and new instruments are acknowledged, the writer holds that conventional navigation is almost sure to remain as one of the few reliable emergency measures.

The article titled "Revolution in Celestial," by Lt. Elmer S. Bendiner, describes one of the new methods of navigation with the aid of an instrument called the Astro-Bine. The development of the instrument is traced, with brief notes about Lt. John Charles Cable, who is credited with its development, and about Frederick Hayes Hagner, inventor of earlier instruments for aerial navigation with whom Lieutenant Cable had worked. The construction and principles of operation of the Astro-Bine are explained.

Lt. Lew H. Morse, in the third article titled "Terse Tables," discusses short cuts in celestial computations and methods for checking them to prevent errors. The principles are illustrated by examples with their mathematical proofs. *Log of Navigation,* February, 1945.

The Snellius Expedition in the Eastern Part of the Netherlands East Indies, 1929–30 constitutes Report No. 788 of Volume III *Meteorological Observations, 1936,* published in the Netherlands and reprinted for the use of the Army Air Forces. It contains a report of the observations recorded during the voyages around the islands of the Netherlands East Indies in the period from about July 26, 1929, to November 12, 1930, made by the Netherlands ship H.M.S. "Willebrord Snellius" under the leadership of P. M. Van Riel, Director of the Amsterdam Branch Office of the Royal Netherlands Meteorological Institute. The text explains the procedure followed and the instruments and other methods of observation used and gives comments about the meteorologic conditions encountered. The data recorded include air pressure, air temperature, sea-water temperature, humidity, wind, state of the sea, rainfall, clouds, and optical phenomena. Separate chapters are given to each of these subjects, giving detailed comments and tables. Tables are grouped at the back of the book giving the hourly and daily figures representing the observations taken. *Weather Division, Headquarters Army Air Forces,* July, 1944.

Weather Factory. Lt. Loyd G. Starret. The regions of the earth where storms originate are likened to "weather factories." The writer explains how wind currents and moisture accumulate and move over the surface of the earth in such a way as to bring changes in the weather. Certain of these "weather factories" are named, and the effects contributed by them are briefly explained. It is stated that bad weather depends on conditions that may be likened to two industrial processes: first, the procurement of raw materials; second, the manufacture of finished goods. Raw material is moist air and the manufacturing process is lifting the air. The finished product becomes a thunderstorm, rain, snow, or fog. *Log of Navigation,* March, 1945.

Civil Aeronautics Administration

Airport Management. This booklet is the first of a series to be published by the Civil Aeronautics Administration concerning airport management, operation, and maintenance. It is intended to aid airport owners and operators in establishing more efficient methods and to assist in placing this important part of the aeronautical industry, and new activity of municipal government, on a sound economic basis. Some of the material used in compiling the booklet was taken from a recent survey of operation methods employed at leading airports in various parts of the country. The booklet deals primarily with the municipal airport because most of the leading airports are owned and operated by municipalities; however, the information and the recommendations also apply to private airports. The sections are as follows: Operating the Airport as a Public Institution; Airport Management; Financing Municipal Airports; Airport Revenue Producing Facilities; General Airport Information.

The booklet contains a directory of Civil Aeronautics Administration regional offices and two appendixes, one giving the details of an airport accounting system and the other an analysis of operating charges. *Civil Aeronautics Administration, Information and Statistics Section.* For sale by the Superintendent of Documents, Washington, D.C., $0.10.

Directory of Airport Managers. This booklet gives the names and locations of airports in the United States and the names of their managers, arranged alphabetically by states. The listings are correct to November 1, 1944. Subsequent changes will be included in a future edition. *Civil Aeronautics Administration, Information and Statistics Section.*

Department of Agriculture

Seven additional reports have been made available in the series issued in cooperation with the Army-Navy-Civil Committee on Aircraft Design Criteria, under the supervision of the Aeronautical Board and in cooperation with the University of Wisconsin. They are as follows:

Supplement to Design of Plywood Webs in Box Beams: Buckling and Ultimate Strength of Shear Webs of Box Beams Having Plywood Face Grain Direction Parallel or Perpendicular to the Axis of the Beams, No. 1318-D. This report is the fifth of a series pertaining to the design of plywood webs in shear for box and I-beams in aircraft. The beams discussed in this report were constructed and tested to

determine whether or not box and I-beams with horizontal and vertical grain plywood webs could be designed using design criteria previously derived for beams with 45° grain plywood webs. These beams were all designed to fail by shear in the webs. The stresses in the compression and tension flanges and in shear in the glue lines joining the flanges and webs were not critical at beam failure.

Supplement to Design of Plywood Webs in Box Beams: The Effect of Repeated Buckling on the Ultimate Strengths of Box Beams with Shear Webs in the Inelastic Buckle Range, No. 1318-E. This report is the sixth of a series pertaining to the design of plywood webs in shear for box and I-beams in aircraft. The beams discussed in this report were constructed and tested to determine whether or not repetitions of the buckling stress adversely affect the strengths of beams with webs that might buckle inelastically. Two-thirds of the design ultimate for the webs was chosen for the maximum repeated load to correspond with the assumed factor of safety of 1.5. Thus, field conditions were simulated in these tests by loading the beams repeatedly to about two-thirds of the design ultimate before loading to failure.

Effects of Certain Defects and Stress-Concentrating Factors on the Strength of Tension Flanges of Box Beams, No. 1513. This report embodies a series of tests arranged to allow the study of effects of bolt holes, various shapes of load blocks, sloping grain, pre-existing compression failures, and of compression failures induced by inverted loading on the tension flanges of box or similar built-up beams of wood and plywood.

Survey of Strength and Related Properties of Yellow Poplar, No. 1516. The purpose of this study is to review the strength and related properties of yellow poplar, particularly as affected by color and stain, and to compare yellow poplar recently produced for use in airplane construction with that previously tested and with spruce. Tests were made on specimens from 96 boards obtained from seven mills in the southern Appalachian district and representing the range of stain and coloration found in stock at those mills. Eleven stain and color groups of sapwood and heartwood were recognized. The tests included were static bending, toughness, compression parallel to grain, compression perpendicular to grain, hardness, shear parallel to grain, cleavage, and tension perpendicular to grain.

Gluing with Low-Temperature-Setting Phenol, Resorcinol, and Melamine Glues, No. 1531. Low-temperature-setting phenol, melamine, and resorcinol glues, as distinguished from cold-setting urea-resin and casein glues, usually require higher than normal room temperatures for curing. It is important to know the time and temperature conditions under which joints of acceptable quality can be made with these glues. To obtain information about curing characteristics of certain commercial low-temperature glues, plywood was made with them by pressing at several temperatures for various lengths of time, and the strength of the joints so made was ascertained by shear tests. The joints increased in strength with increased temperature and time of heating until the glue became sufficiently cured to develop the full strength of the wood. Differences between glues in rate of development of joint strength were taken as indicative of diverse curing characteristics.

Bleed-Through of Glue in Aircraft Plywood, No. 1541. Glue deposits on the surfaces of plywood panels which result from the penetration of glue from the joints during hot-pressing are commonly designated as "bleed through." Such surface glue deposits are rather common on thin aircraft plywood, particularly on plywood with thin mahogany, khaya, or yellow-birch face plies. The frequency of requests for information about aircraft plywood showing bleed-through indicated a need for a general investigation of the problem and resulted in the studies described in this report. The specific problems investigated were as follows: (1) the factors contributing to the development of bleed-through; (2) the secondary gluing of plywood showing various amounts of bleed-through; and (3) the quality of primary glue bonds in plywood showing various amounts of bleed-through.

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Breaking Radius of Discolored Wood in Aircraft Veneers, Forest Pathology Special Release No. 22. The breaking radii of variously discolored veneers of six different hardwood species were small enough, for most of the discolorations, to indicate that such veneers can be used successfully on members having curved surfaces. When expressed in terms of the minimum radius of curvature attained without fracturing, the breaking radius in nearly all cases was small enough to be amply covered by a minimum factor of safety of 3, as suggested in ANC-19, *Wood Aircraft Inspection and Fabrication.* The only definite exception was veneer discolored by decay fungi. Some uncertainty as to suitability for sharply curved surfaces was indicated, however, for mineral streaks in yellow birch, for the dark reddish-purple variety of mineral stain in yellow poplar, and for gum streaks in mahogany and khaya. *Department of Agriculture, Forest Service, Forest Products Laboratory,* Madison, Wis.

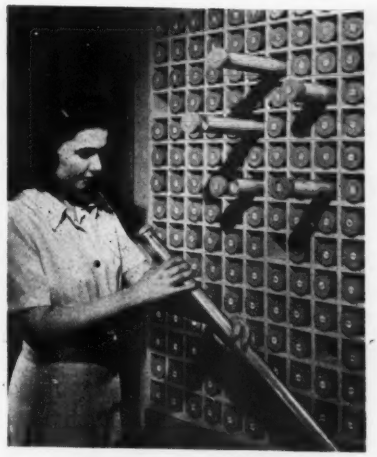
The Library of Congress

Renegotiation of War Contracts: A Selected List of References. This bibliography brings together a selected list of published matter dealing with renegotiation of war contracts. It incorporates a total of 176 references. *The Library of Congress, General Reference and Bibliography Division,* Washington, D.C., August, 1944.

National Advisory Committee for Aeronautics

The Minimum Energy Loss Propeller. N. Poliakhov. Report No. 455 of the Central Aero-Hydrodynamical Institute, Moscow, 1939. Various cases are presented of the solution of the problem of the most efficient propeller. More general cases were considered than the one by Betz in 1919—namely, that of a propeller under a limiting light load. The problem is solved directly and also with the aid of the Ritz method, which became readily applicable after the writer proposed a method for the solution of the propeller problem, in general, with the aid of trigonometric series. The design of a propeller with the aid of this method is given, and an analysis is made of the effect of the fuselage and of the viscosity coefficient on the character of the solution of the variational problem. *Technical Memorandum No. 1067,* March, 1945.

The Friction of Piston Rings. Hans W. Tischbein. Translation of "Reibung an Kolbenringen," *Kraftstoff,* December, 1939, January, February, and March, 1940. The coefficient of friction between a piston ring and cylinder liner was measured in relation to gliding acceleration, pressure, temperature, quantity of oil, and quality of oil. Comparing former lubrication-technical tests, conclusions are drawn as to the state of friction. The coefficients of friction as figured out according to the hydrodynamic theory were compared with those measured by tests. Special tests were made on "oiliness." The highest permissible pressure was measured. The ratio of pressure is discussed. *N.A.C.A. T.M. No. 1069,* March, 1945.



Photograph Courtesy Eastman Kodak Company

Transparent Tenite tubing is used as storage containers for aviation tool blue prints. The prints are clearly visible through the plastic.

New Method of Determining the Polar Curve of an Airplane in Flight. B. N. Yegorov. Report No. 418 of the Central Aero-Hydrodynamical Institute, Moscow, 1939. A fundamental defect of existing methods for the determination of the polar of an airplane in flight is the impossibility of obtaining the thrust or the resistance of the propeller for any type airplane with any type engine. The new method is based on the premise that for zero propeller thrust the mean angle of attack of the blade is approximately the aerodynamic chord of the profile section. This angle was determined from flight tests. Knowing the mean angle of the blade setting, the angle of attack of the propeller blade at zero thrust can be found and the propeller speed in gliding can be obtained. The experimental check of the new method carried out on several airplanes gave positive results. The basic assumptions for the construction of the polars and the method of analyzing the flight data are given. *N.A.C.A. T.M. No. 1076,* March, 1945.

Navy Department

Physics for Aviation. This book is one of the "Flight Preparation Training Series." It tells what knowledge of physics is required by students entering aviation. The subject is discussed in easy-to-understand language, and problems with their answers are included. *Aviation Training Division, Office of the Chief of Naval Operations.*

U.S. Coast and Geodetic Survey

Elements of Map Projection with Applications to Map and Chart Construction. Charles H. Deetz and Oscar S. Adams. The aim of this publication is to present in simple form some of the ideas that constitute the foundation of the subject of map projections. It is divided into two parts: the first treats the theoretic side in a form that is as simple as possible; the second part takes up the subject of the practical construction of some of the most important projections, the purpose being to give such detailed instructions as are necessary to present the matter in a clear and simple manner. This fifth edition contains a new plate showing the outline of the United States in which the Lambert projection is superimposed on the Mercator projection on a scale sufficiently large to illustrate the differences in their properties and resulting delineation. Figures illustrating the nature of the Mercator projection as compared with the perspective projection upon the tangent cylinder have also been added with explanatory text. A new equal-area projection of the hemispheres is included, as well as a demonstration of the property of isoperimetric curves which is inherent on all equal-area projections. Other features, including Tissot's Indicatrix as applied to the sinusoidal projection, are illustrated or briefly noted. *Special Publication No. 68, U.S. Department of Commerce, Coast and Geodetic Survey.* For sale by Superintendent of Documents, Washington, D.C., $1.00.

U. S. Naval Observatory

Sky Diagrams, 1945. This booklet contains a series of circular diagrams showing the principal navigational objects on an azimuthal equidistant projection with center at the zenith for different hours of the night and for different latitudes. These diagrams are useful in selecting the most suitable stars and planets for navigation on a given flight and for identifying prominent celestial bodies at the time of observation. There is a series of diagrams for each month showing the sky for six different latitudes at two-hour intervals during the night. The diagrams for a given latitude are arranged in a row and show the changes in the sky during the night. The first regular edition of this publication appears in booklet form for distribution and, in addition, is intended to incorporate the diagrams in the *American Air Almanac* beginning with the volumes for 1946. *Nautical Almanac Office.* For sale by Superintendent of Documents, Washington, D.C., $0.15.

U.S. Office of Education

Vocational-Technical Training for Industrial Occupations. A report on vocational-technical training is made by the consulting committee appointed by the U.S. Commissioner of Education with the cooperation of the Federal Security Agency. The advice contained in the report is pertinent to vocational objectives, vocational out-

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lets, and standards of training for a new area of vocational education of less than college grade. Conclusions and recommendations are preceded by a brief summary of the report and discussions dealing with the following: characteristics of vocational-technical training; objectives, procedures, and organization of the report; some developments and trends affecting vocational-technical training; the nature of industry's need for vocational-technical training; present programs and facilities for vocational-technical training; and planning programs for vocational-technical training. A bibliography and an index are included. *Vocational Division Bulletin No. 228, Vocational-Technical Training Series No. 1.* For sale by Superintendent of Documents, Washington, D.C., $0.40.

War Department

Principles of Cold Weather Clothing and Equipment. The purpose of this manual is to insure the proper use, care, and maintenance of cold-weather clothing and equipment. It deals with all important items in these categories used in cold climates and in the mountains. The chapter on clothing contains sections dealing with the basic principles of keeping warm: body clothing, footwear, handwear, and headgear. The chapter on equipment is divided into sections about equipment for sleeping, cooking, mountain climbing, skiing, and snowshoes, as well as instructions for making camp and packing equipment. *War Department Technical Manual TM 10-275*, October, 1944. For sale by Superintendent of Documents, Washington, D.C., $0.20.

Operations in Snow and Extreme Cold. This Basic Field Manual gives instructions for conducting military operations under conditions of snow and extreme cold, emphasizing the tactical and logistic limitations imposed by adverse climatic conditions and the differences in the special equipment, training, and procedures necessary to overcome these limitations. Following a general discussion of the basic principles and the major problems involved, there are chapters on rations and their preparation, clothing, shelter and heat, snowshoes, skiing, oversnow vehicles, animal transport, equipment, special care of weapons and equipment, and tactical operations. *War Department Basic Field Manual FM 70-15*, November, 1944. For sale by Superintendent of Documents, Washington, D.C., $0.40.

Jungle Warfare. This Field Manual is intended to train the soldier to adjust himself to life in the jungle, to take advantage of those factors in the environment which will help him to live successfully there, and to use those factors against the enemy. The introductory chapter gives information about the nature of the jungle and its effects on troops and operations. Other chapters refer to health, hygiene, sanitation, jungle service, and jungle operations. Appendixes give instructions about native plants and the use of the jungle machete. *War Department Field Manual FM 72-20*, October, 1944. For sale by Superintendent of Documents, Washington, D.C., $0.40.

War Production Board

Facts for Industry. Series 51-2-3 gives a report of total production of munitions in 1944 and the scheduled output for January and February, 1945. The statistics for production of airplanes are divided into the classifications of bombers, fighters and naval reconnaissance craft, transports, trainers, and communication and special-purpose planes. The figures show the number, air-frame weight, and value. *Military Division, Bureau of Program and Statistics, War Production Board*, Washington, D.C.

British Air Commission

The Hawker Tempest V Fighter Plane. The second official statement about the Hawker Tempest Mark V gives the following details: The wings have a thin, high-speed section with low camber and maximum thickness at 37.5 per cent chord. They are elliptically shaped in plan view, with square-cut tips, having no dihedral on the inner portion but dihedral on the portion outboard of undercarriage pivot. Frise-type ailerons are attached to the outer sections. Split trailing-edge flaps are mounted between ailerons and fuselage. Engine mounting and center fuselage are basically a rectangular, rigidly braced structure of steel tubes assembled with flat plate fittings and machined stampings. The rear fuselage aft of the pilot's cockpit is a monocoque structure consisting of a stressed-skin flush riveted to oval-shaped frames and longitudinal stringers. The forward portion of the fuselage is covered with detachable metal panels giving a fair line and easy access to the cockpit equipment and controls.

The tail unit, a cantilever monoplane type with large dorsal fin, has an all-metal stressed-skin covered fin and tail plane. It has metal-covered elevators and fabric-covered rudder. Adjustable trimming tabs are mounted in the movable surfaces. The landing gear is of retractable type, hydraulically operated. Main wheels retract inwardly into wells in the underside of the inner portion of wings, and the tail wheel retracts forward into the fuselage. Doors on the underside of the fuselage close over and seal the wheel wells of both the main undercarriage and tail wheel when retracted.

The power plant consists of one Napier Sabre 11-B 24-cylinder H type, liquid-cooled, sleeve-valve engine of 2,400 hp. A low-velocity duct beneath the engine houses the radiator and oil cooler, with air intake in the center of the assembly. A four-bladed de Havilland constant-speed propeller is fitted. The large main fuel tank and oil tank are carried in the fuselage forward of the pilot. Additional fuel tanks are mounted between the main spars of the wing and, in some aircraft, in the leading edge of the port wing.

The enclosed cockpit located over the wing has a bulletproof windshield and armor forward and aft of the pilot. The transparent sliding hood of blown shape can be jettisoned by the pilot in an emergency. Armament consists of four 20-mm. cannon in the wings, firing outside the propeller disc.

The dimensions are: span, 41 ft.; length, 33 ft. 8 in.; height, 16 ft. 1 in.; wing area, 302 sq.ft. Weight, fully loaded, is about 11,500 lbs., and maximum speed is about 435 m.p.h. The plane's tactical radius of action is about 500 miles; this can be extended by auxiliary fuel tanks. The ceiling is about 36,000 ft. *British Air Commission*, Washington, D.C.

British Air Ministry

The Civil Aviation Communications Handbook. This Air Ministry pamphlet is limited to radio and teleprinter procedure. It gives the essential information and instructions for all kinds of air-land communication and is in general agreement with international regulations. A later and more complete edition is promised when agreement is reached concerning international rules now under consideration. *Air Publication 1692*, September, 1944; *British Information Services*, New York, $0.45.

British Information Services

First Blows: Britain's Fight Against Japan. This illustrated book-

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BY PHILLIP ANDREWS

Editor and Publisher of "Air News" and "Air Tech" tells how delicate flight research instruments run aircraft "behavior tests" while the pilot flies.

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let outlines briefly the part Britain has played so far in the fight against Japan. It is limited almost entirely to the contribution of the United Kingdom, with only passing reference to the services of other nations of the British Empire. One chapter traces what is called the Year of Retreat, 1941–1942; another deals with the Year of Building, 1942–1943. Among the services featured are those of the aircraft carrier H.M.S. "Victorious" and the development of the method of delivering supplies by parachute, credited to the late Major Gen. Orde Wingate. *British Information Services*, New York.

British Ministry of Aircraft Production

The Interference on a Wing Spanning a Closed Tunnel Arising from the Boundary Layers on the Side Walls, with Special Reference to the Design of Two-Dimensional Tunnels. J. H. Preston. This investigation forms part of a study of the factors that should fix the dimensions of a proposed two-dimensional tunnel. It is desirable that the sectional characteristics of large chord wings with flaps should be measured with considerable accuracy. At the same time it is necessary to restrict tunnel dimensions because of considerations of economy of power and of time and cost of model manufacture. The height of the tunnel can be fixed from considerations of roof and floor interference. The width of the tunnel will be governed by the effects of the boundary layers on the side walls.

These give rise to two effects. First, they cause a loss of lift at sections of the wing lying within them, giving rise to trailing vortices that in turn affect the spanwise distribution of lift over the whole wing. An approximate and elementary theory is developed which is in qualitative agreement with experiment. The interference is appreciable for wings of chord greater than half the tunnel width. It is suggested that it could be effectively removed by increasing the chord of the endpieces, where they enter the boundary layers, in such a manner that the product of the chord and the velocity in the boundary layer at a given distance from the wall remains constant. The second effect arises when there is a large extent of laminar flow present on a wing. Inward spread of turbulence takes place from the walls, and on large chord wings the extent of this spread at the trailing edge is serious. This, in conjunction with considerations of the span of the center portion of the wing required for accurate force measurement, fixes the width of the tunnel. *Ministry of Aircraft Production, R. & M. No. 1924, British Information Services*, New York, $0.60.

Note on the Calculation of Vibration Frequencies for an Aero-Engine Installation. G. C. J. Dalton and F. S. Shaw. The writers discuss the application of methods for the calculation of natural frequencies of vibration to an aircraft-engine installation. Reference is made to two earlier papers: one concerned with continuous systems such as shafts or propeller blades, and the other concerned with systems of restricted but considerable freedom, such as a multicylinder crankshaft with gears and other devices attached, of which the torsional frequencies are to be calculated. It is noted that methods are now available whereby the natural frequencies, although not calculable exactly, can be "bracketed" between limits as narrow as may be desired. These are based on Lagrange's equations formulated in terms of generalized coordinates.

The methods are applied to an aircraft-engine installation, in which the distortion of the engine itself is neglected and the inertia of the supporting members is disregarded. The problem is simplified, as is customary, by disregarding both the movement and distortion of the supporting airplane. It is noted that any possible displacement of the engine will consist of three center-of-gravity displacements and three component rotations about the center of gravity. Taking these six independent coordinates, an expression is formulated for the total potential and kinetic energies. The simplified problem is exhibited in a sketch, the equations and other calculations are worked out, and the results are tabulated. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1917. British Information Services*, New York, $0.40.

Polish Ministry of Industry, Commerce and Shipping

Poland's Possible Contribution to Future Air Transport. This pamphlet has been prepared to acquaint those interested in air transport with Poland's possibilities for active participation in the further developments of air transportation and for the inclusion of the nation in a general scheme of international air traffic. The purpose of the pamphlet is to impart useful information concerning conditions that result from Poland's geographic position and natural resources. The major part of the book is taken up with maps showing the topography, wind distribution, air pressure and temperature, precipitation, airports and airfields. Other maps show the relative location of the country with respect to European, African, and Asiatic air routes and the world postal services. Graphs and maps give data about Poland's foreign trade. *Aeronautical Department, Polish Ministry of Industry, Commerce, and Shipping*, London, 1945.

(*Continued from page 53*)

Economics in Aeronautics. Address inquiries to Box 286, Institute of the Aeronautical Sciences.

Engineering Test Pilot—Ten years' flying experience, Army trained, three years of experimental test flying with prominent manufacturer of multi- and single-engined military airplanes. B.S.-M.E. degree, majored in Aeronautical Engineering. Proven executive ability. Desires to change company affiliation. West Coast preferred. Address inquiries to Box 279, Institute of the Aeronautical Sciences.

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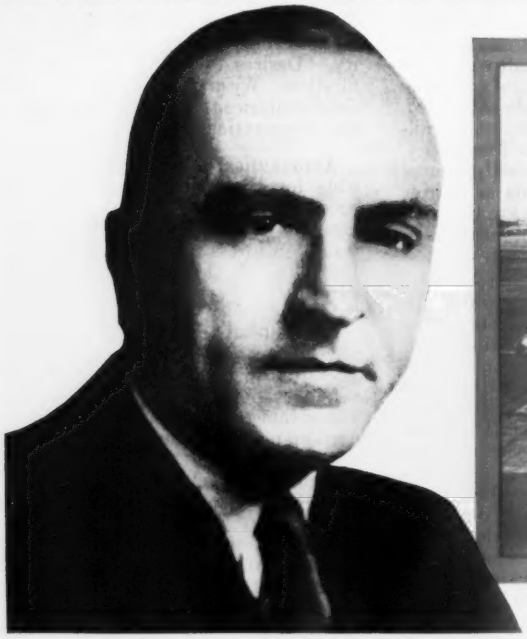
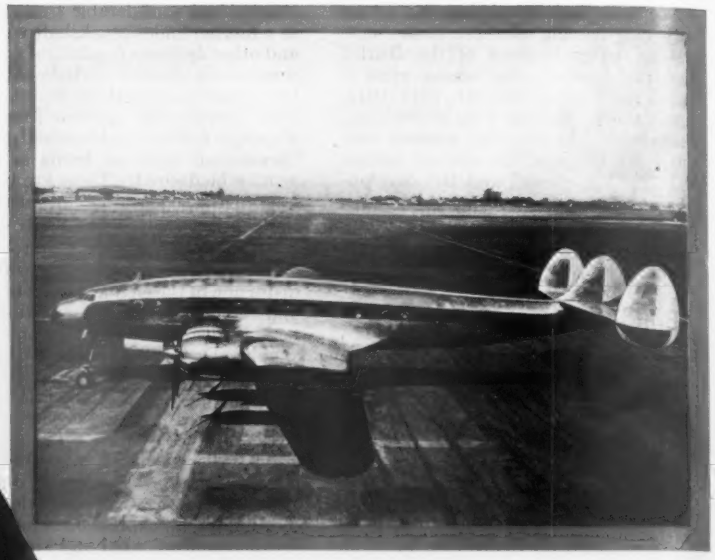
This is the twenty-second of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME





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Source Material

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The prices listed are for single issues and yearly subscriptions to recipients in the United States. Subscription prices to house organs are in many cases not available but may be obtained directly from the offices of the organization.

The frequency of publication is indicated by the following symbols: M, monthly; SM, semimonthly; BM, bimonthly; W, weekly; BW, biweekly; D, daily; Irreg., irregularly; Q, quarterly.

Periodicals

Aero Digest, 515 Madison Ave., New York 22, N.Y., SM, $0.50, $3.00.

The Aero Field, Francis J. Field, Ltd., Sutton Coldfield, England, 10 issues per year, 6*d*., 5*s*.

Aero Products, 271 Madison Ave., New York 16, N.Y., M.

Aeronáutica, Avda. de Mayo 1370, Buenos Aires, M, $0.60 (pesos), $4.50 (pesos).

Aeronautics, Tower House, Southampton St., Strand, London, W.C.2, M, 2*s*., 26*s*. 6*d*.

The Aeroplane, Bowling Green Lane, London, E.C.1, W, 1*s*., 58*s*.

The Aeroplane Spotter, Bowling Green Lane, London, E.C.1, BW, 3*d*., 8*s*. 8*d*.

Air Age Education News, Air Age Education Research, 100 E. 42d St., New York 17, N.Y., BM.

Air Facts, 30 Rockefeller Plaza, New York 20, N.Y., M, $0.25, $3.00.

Air Mail Magazine, A. Phillips, Newport, Monmouthshire, M, 4*d*., 5*s*.

Air News, 545 5th Ave., New York 17, N.Y., M, $0.20, $2.00.

Air Pilot and Technician, 515 Madison Avenue, New York 22, N.Y., M, $0.35, $3.00.

Air Tech, 545 5th Ave., New York 17, N.Y., M, $0.25, $2.50.

Air Trails Pictorial, 122 E. 42d St., New York 17, N.Y., M, $0.25, $2.50.

Air Transport, 330 W. 42d St., New York 18, N.Y., M, $0.50, $5.00.

Air Transportation, 10 Bridge St., New York 4, N.Y., M, $0.50, $5.00.

Air World, 241 Church St., New York 13, N.Y., BM, $0.15, $0.90.

Aircraft, 62 Flinders St., Melbourne, C.1, M, 1*s*. per issue.

Aircraft Engineering, 12 Bloomsbury Sq., London, W.C.1, M, 2*s*. 3*d*., 26*s*.

Aircraft Production, Dorset House, Stamford St., London, S.E.1, M, 2*s*. 6*d*., £1 14*s*. 6*d*.

Airlanes, 340 W. 57th St., New York 19, N.Y., M, $0.25, $2.50.

Airmail Digest, Charles B. Charmatz, Sylvania, Ohio, Irreg.

Airports, 1170 Broadway, New York 1, N.Y., M, $0.25, $3.00.

Aluminum and Magnesium, 425 W. 25th St., New York 1, N.Y., M, $3.00 yr.

American Aviation, American Bldg., Washington 4, D.C., SM, $0.25, $4.00.

American Aviation Daily, American Bldg., Washington 4, D.C., D, $170 yr.

American Aviation Directory, American Bldg., Washington 4, D.C., Semi-annually, $5.00, $7.50.

American Aviation Traffic Guide, 139 N. Clark St., Chicago 2, Ill., M, $0.50, $5.00.

The American Mercury, 570 Lexington Ave., New York 22, N.Y., M, $0.25, $3.00.

Automotive and Aviation Industries, Chestnut & 56th Sts., Philadelphia 22, Pa., SM, $0.25, $1.00.

Avia, Victoria 788, Buenos Aires, M, $0.50 (*m/n*), $5.00 (*m/n*).

Aviação, Rua Uruguiana, 104, Rio de Janeiro, M, $4.00 (cruzeiros), $40 (cruzeiros).

Aviación, 429 H. W. Hellman Bldg., Los Angeles 13, Calif., BM, $1.00 yr.

Aviation, 330 W. 42d St., New York 18, N.Y., M, $0.50, $3.00.

Aviation and Yachting, 2816 Eaton Tower, Detroit 26, Mich., M, $0.25, $2.00.

Aviation Equipment, 1170 Broadway, New York 1, N.Y., M.

Aviation Maintenance, 205 E. 42d St., New York 17, N.Y., M, $0.50, $5.00.

Aviation News, 1357 National Press Bldg., Washington 4, D.C., W, $0.50, $5.00.

Aviation Review, 31 Willcocks St., Toronto 5, Ontario, M, $0.25, $3.00.

Aviation Service Magazine, 549 W. Washington Blvd., Chicago 6, Ill., BM.

British Plastics, Dorset House, Stamford St., London, S.E.1, M, 1*s*. 6*d*., 20*s*.

Canadian Air Cadet, 122 Wellington St., Ottawa, Ontario, M, $0.10, $1.00.

Canadian Aviation, 481 University Ave., Toronto 2, Ontario, M, $0.25, $2.00.

Chile Aéreo, Club Aéreo de Chile, Av. Bulnes 80, Santiago de Chile, M, $5.00 (pesos), $50 (pesos).

Collier's, The Crowell-Collier Publishing Co., Springfield, Ohio, W, $0.10, $3.00.

Commercial Aviation, 341 Church St., Toronto, Ontario, M, $0.25, $3.00.

Contact, 113 W. 42d St., New York 18, N.Y., M, $0.20, $2.00.

Current Aviation, 400 S. Front St., Columbus 15, Ohio, W, $0.80 yr.

D and W, 100 E. 42d St., New York 17, N.Y., M, $0.30, $3.00.

Diesel Power & Diesel Transportation, 192 Lexington Ave., New York 16, N.Y., M, $0.35, $3.00.

EMCO Monthly Journal, Marks Stamp Co., Ltd., 258 College St., Toronto 2, Ontario, M, $0.50 yr.

The Engineer, 28 Essex St., Strand, London, W.C.2, W, 1*s*., £3 3*s*.

Engineering, 35 Bedford St., Strand, London, W.C.2, W, 1*s*. 2½*d*., £3 3*s*.

Engineering Materials and International Power Review, Africa House, Kingsway, London, W.C.2, BM, 3*s*., 15*s*.

Engineering News-Record, 330 W. 42d St., New York 18, N.Y., W, $5.00 yr.

The Engineers' Digest (American Edition), 1 Madison Ave., New York 10, N.Y., M, $0.75, $7.50.

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Mundo Aeronáutico, Rivadavia 945, Buenos Aires, M, $0.30 (pesos), $4.00 (pesos).

The N.A.T.A. Dispatch, National Aviation Trades Assn., 214 E. Armour Blvd., Kansas City 2, Mo., 36 issues per yr.

Official Aircraft Price Guide, Aircraft Advisory Service, Inc., P.O. Box 81, Columbus 16, Ohio, Q, $6.50 yr.

The Official Foreign Air Mail Guide, 11 W. 42d St., New York 18, N.Y., M, $1.50 yr.

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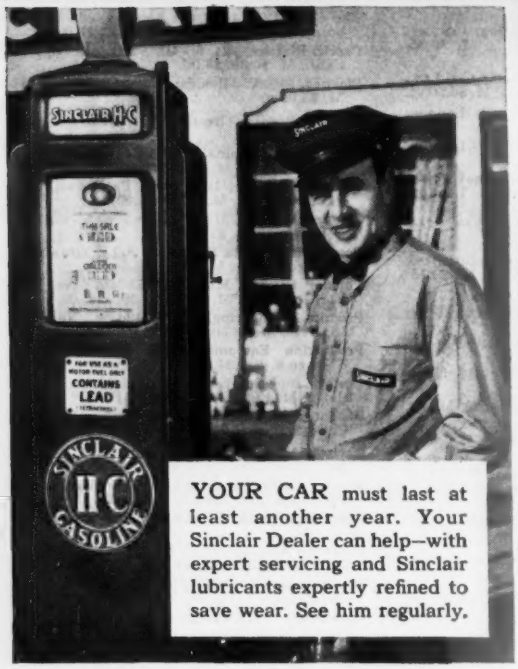

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Aeronautical Chamber of Commerce of America, Inc., Weekly Washington Bulletin, 610 Shoreham Bldg., Washington 5, D.C., W.

Aeronautical Engineering Review, Institute of the Aeronautical Sciences, Inc., 1505 RCA Bldg. West, 30 Rockefeller Plaza, New York 20, N.Y., M, $0.30, $3.00.

The Air Force Woman, The National Assn. of Air Forces Women, 1702 K St., N.W., Washington 6, D.C., M.

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The Air Line Pilot, The Air Line Pilots Assn., International, 3145 W. 63d St., Chicago 29, Ill., M.

Airport Digest, National Aeronautic Assn., 1025 Conn. Ave., N.W., Washington 6, D.C., M.

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Aviation Progress, County Chamber of Commerce, Los Angeles, Calif., M.

Aviation Writers Assn., Newsletter, P.O. Box 856, Grand Central Annex, New York 17, N.Y., Irreg.

Boletín de Aviación, National Aeronautic Assn., 1025 Conn. Ave., N.W., Washington 6, D.C., M.

Chirp, The Early Birds, Lt. Col. Ernest Jones, Secretary, 3401 16th St., N.W., Washington, D.C., Irreg.

Civil Air Patrol League, News, 545 5th Ave., New York 17, N.Y., M.

Conference of International Air Traffic Operators, Bulletin, 31-32, Haymarket, London, S.W.1, M, 1*s*., 10*s*. 6*d*.

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The Foundation, Engineering Society of Detroit, 100 Farnsworth Ave., Detroit, Mich., M.

The Franklin Institute, Journal, Benjamin Franklin Parkway at 20th St., Philadelphia, Pa., M, $0.60, $6.00.

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National Aeronautics, National Aeronautic Assn., 1025 Conn. Ave., Washington 6, D.C., M, $6.00 yr.

New York University, Contributions from the College of Engineering, University Heights, New York 53, N.Y., Irreg.

Ohio State University, Engineering Experiment Station, News, Columbus, Ohio, M.

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Photogrammetric Engineering, The American Society of Photogrammetry, P.O. Box 18, Benjamin Franklin Sta., Washington, D.C., $1.50 per issue.

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Polish Engineering Review, Association of Polish Engineers in Canada, 3432 Drummond St., Montreal, Quebec, BM, $0.50, $3.00.

Press Summary, Society of British Aircraft Constructors, Ltd., 32, Saville Row, London, W.1, W.

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West Coast Air Mail Society, Bulletin, Ralph A. Freiburg, 4142 26th St., San Francisco 14, Calif., BM.

Wings Club, Inc., Bulletin, 50 Vanderbilt Ave., New York 17, N.Y., M.

Government Publications

Aerodrome Abstracts, compiled by the Department of Scientific and Industrial Research and issued in collaboration with the Air Ministry, The Institution of Civil Engineers, St. George St., Westminster, London, S.W.1, M.

Aeronáutica, Clasificador F-468, Santiago de Chile, M, $6.00 (pesos), $50 (pesos).

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Army News, Bureau of Public Relations, War Dept., Washington 25, D.C., SM.

Australia, Council for Aeronautics, Reports, Box 4331, G.P.O., Melbourne, Irreg.

Bulletin of War Medicine, British Information Services, 30 Rockefeller Plaza, New York 20, N.Y., M, $0.40, $4.65.

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Gt. Brit., Air Ministry, Library, Additions List, The Librarian, Whitehall, London, S.W.1, M.

Gt. Brit., Air Registration Board, Notice to Licensed Aircraft Engineers and to Owners of Civil Aircraft, Brettenham House, Strand, London, W.C.2, Irreg.

Gt. Brit., Ministry of Aircraft Production, Abstracts from the Scientific and Technical Press, and Titles and References of Articles and Papers Selected from Publications (Reviewed by R.T.P. 3), Together with List of Selected Translations, The Royal Aeronautical Society, 4, Hamilton Place, London, W.1, M.

Gt. Brit., Ministry of Aircraft Production, Translations, The Secretary (R.T.P. 3), Millbank, London, S.W.1, M.

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Technical News Bulletin of the National Bureau of Standards, U.S. Govt. Printing Office, Washington 25, D.C., M, $0.05, $0.50.

U.S., Army Air Forces, Air Technical Service Command, Translations, Wright Field, Dayton, Ohio, Irreg.

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U.S., Civil Aeronautics Administration, Technical Development Notes, Technical Development Reports, Washington 25, D.C., Irreg.

U. S., Forest Products Laboratory, Progress Reports, Madison, Wis., Irreg.

U.S., N.A.C.A., Technical Memorandums, National Advisory Committee for Aeronautics, Washington 25, D.C., Irreg.

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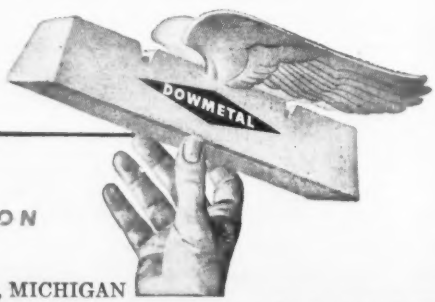

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Airport Manager's Service Bulletin, Aero Insurance Underwriters, 111 John St., New York 7, N.Y., BM.

Allisonews, Allison Division, General Motors Corp., Indianapolis, Ind., SM.

Aluminum News Letter, Aluminum Co. of America, Pittsburgh 19, Pa., M.

The ASCo Aircrafter, American Stove Co., 1825 E. 40th St., Cleveland 3, Ohio, BW.

Aviation Bulletin, The British Aviation Insurance Co. Ltd., 500 Place d'Armes, Montreal, Quebec, M.

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The Ballardair, The Walter M. Ballard Corp., 331 Madison Ave., New York 17, N.Y., M.

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The Bee-Hive, United Aircraft Corp., East Hartford, Conn., BM.

Bell Aircraft News, Bell Aircraft Corp., Buffalo, N.Y., W.

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Bell Laboratories Record, 463 West St., New York 14, N.Y., M, $2.00 yr.

The Bell Ordnance News, Bell Aircraft Corp., Burlington, Vt., W.

The Bellringer, Bell Aircraft Corp., 2050 Elmwood Ave., Buffalo, N.Y., M.

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British Airways News Letter, British Overseas Airways Corp., Airways House, London, S.W.1, M.

Bulaero, Cal-Aero Technical Institute, Glendale, Calif., M.

Bulletin of Technical Data for the Plywood Industry, The Resinous Products & Chemical Co., 222 W. Washington Sq., Philadelphia 5, Pa., Irreg.

Caminos del Aire, Pan American Airways, Inc., Bolivar 18, Mexico, D.F., M.

Canadian Car Journal, English Edition, Canadian Car & Foundry Co. Ltd., 621 Craig St., West, Montreal, Quebec, M.

Cessquire, Cessna Aircraft Co., Wichita, Kan., M.

The Chance Vought News, Chance Vought Aircraft Div., United Aircraft Corp., Stratford, Conn., SM.

Chicago Douglas Airview News, Douglas Aircraft Co., Inc., Park Ridge, Ill., W.

Circle-News, The B. F. Goodrich Co., 500 S. Main St., Akron 11, Ohio, W.

Classroom Clipper, Pan American Airways, Inc., 135 E. 42d St., New York 17, N.Y., M.

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The Connecting Link, Link Aviation Devices, Inc., Binghamton, N.Y., BM.

Construction Glues, I. F. Laucks, Inc., 911 Western Ave., Seattle, Wash., BM.

The Continental Eagle, Continental Air Lines, Inc., Municipal Airport, Denver, Colo., M.

Convair News, Consolidated Vultee Aircraft Corp., Miami, Fla., W.

Curtiss Fly-Leaf, Airplane Div., Curtiss-Wright Corp., Municipal Airport, Buffalo, N.Y., BM.

Curtiss Wright-er, Curtiss-Wright Corp., Lambert Field, St. Louis, Mo., W.

Daggett Douglas Airview News, Douglas Aircraft Co., Inc., Daggett, Calif., W.

De Havilland Mosquito, de Havilland Aircraft of Canada, Ltd., Postal Sta. L, Toronto, Ontario, M.

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Dow Diamond, The Dow Chemical Co., Midland, Mich., BM.

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Edo Weekly Log, Edo Aircraft Corp., College Point, L.I., N.Y., W.

The Educational Focus, Bausch & Lomb Optical Co., Rochester, N.Y., Q.

El Segundo Douglas Airview News, Douglas Aircraft Co., Inc., El Segundo, Calif., W.

Electrical Communication, International Standard Electric Corp., 67 Broad St., New York, N.Y., Q, $0.75, $3.00.

Ethyl News, Ethyl Corp., 405 Lexington Ave., New York 17, N.Y., M.

FAD, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp., Hagerstown, Md., BW.

Fairchild News, Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N.Y., M.

The Faircrafters, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp., Burlington, N.C., W.

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The 1945 edition of this international reference book contains data on the latest aircraft engines of the United Nations and the enemy nations, including jet-propulsion engines and air-borne auxiliary power plants. The contents have been revised to January, 1945, and much of the material is exclusive.

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Air Chief Marshal Tedder says in a Foreword: "It has already deservedly made its mark as a useful, stimulating, and convenient guide to the principles of aeronautics." Flight Publishing Company, London, 1944; 211 pages, 7*s*. 6*d*.

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In the data section each of the leading Allied and enemy planes is described with as complete specifications as may be given at this time. Duell, Sloan and Pearce, Inc., New York, 1944; 296 pages, $4.75.

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Herbert S. Zim

Contents: The Story of Things Not Yet; Basic Principles; The Origin of the Rocket Idea; Rockets in Battle; Powder Rockets; Rocket Vehicles; Modern Battle Rockets; Aerial Rockets; Rockets for the Future; Decomposition or Combustion; The Liquid Fuels; Rocket Motors; Experimental Rockets; High-Altitude Rockets; Escape from the Earth; The Goals of Interplanetary Rockets; Interplanetary Problems; Jet Propulsion That Works; The Launching of the Squirt; Jets and Near-Jets; The Secret Weapon; The Future of Rockets; The American Rocket Society and Others.

As the use of rockets and jet propulsion expands, each new book treating this field adds further information that has been released by the military authorities. This book brings the reader up to the present and gives speculative opinions as to the future. The history of the development of reaction motive power is traced so that the work of the pioneers is differentiated and evaluated.

In the chapters dealing with rockets, the different fuels used are discussed and the advantages and disadvantages of each are stated. All the known types from the skyrocket of fireworks displays to the large V-2 are described in detail. As is usual, the projected interplanetary rocket theories are explained with caution. The jet-propulsion aircraft that have such a promising future are given their prominent place in the picture of postwar combat development.

The book is written for the public, and the technical parts, while given authoritative backing, do not require any broad knowledge of engineering. Harcourt, Brace and Company, New York, 1945; 326 pages, $3.00.

Theory of Flight

Richard Von Mises

Contents: The Atmosphere at Rest; Bernoulli's Equation: Rotation and Circulation; Momentum and Energy Equations; Perfect and Viscous Fluids: Types of Flow; Air Resistance, or Parasite Drag; Fundamental Notions: Geometry of Wings; Empirical Airfoil Data; The Wing of Infinite Span; The Wing of Finite Span; Additional Facts About Wings; The Propeller; Outline of Propeller Theory; The Airplane Engine; The General Performance Problem; Analytical Methods of Performance Computation; Special Performance Problems; Moment Equilibrium and Static Stability; Nonuniform Flight; General Theory of Motion and Stability; Dynamic Stability of an Airplane.

In writing this book the author's aim has been to provide a text to develop interest in, and an understanding of, the fundamental principles that underly the design and operation of aircraft. The book is intended particularly for students who have reached the border line between the last year of college and the first year of graduate work. It is assumed that the reader is acquainted with the principles of calculus and has received some training in general mechanics.

The text is divided into five main parts—Equilibrium and Steady Flow in the Atmosphere; The Airplane Wing; Propeller and Engine; Airplane Performance; Airplane Control and Stability. Under these main headings the appropriate chapters are grouped and each chapter is divided into subsections. At the end of these sections problems are stated, based on the subject treated, and these are to be worked out by the student. For all main subjects numerical examples are worked out in detail within the context. McGraw-Hill Book Company, Inc., New York, 1945; 629 pages, $6.00.

Proceedings of the Second Annual National Aviation Clinic

Contents: The Call to Order; Aviation and the Government; Role of the Personal Airplane in Tomorrow's America; The Disposition of Warborn Surpluses; Aviation's Crossroads and Highways—Airports and Traffic Control; Travel and Trade By Air; Air Transportation—Its Military Significance; Fixed Base and Feeder Line Operation; Air Power; Training and Education in the Sciences and Arts of the Air.

This report of the proceedings at the meeting at Oklahoma City covers the general subject of domestic aviation planning. Well-known speakers gave their opinions and these were discussed by delegates who were specialists in the many fields of nonmilitary aviation.

The relationship of aviation to Government brought out wide differences of opinion. The role of the personal airplane in tomorrow's America was stated in a hopeful spirit. Airports and traffic control were considered; fixed-base and feeder-line operation occupied one session; and, at the close of the meeting, education as relating to aviation was examined.

The book has the advantage of informality and plain speaking, with the discussions bringing out the points of difference and the resolutions giving an indication of the subjects uppermost in the minds of those who are giving thought to postwar civil aviation.

In addition to the reports of the formal sessions, the book contains the rules and procedure of the conference, the order of the program, the text and discussions of the resolutions, and lists of the committees and delegates. Harlow Publishing Corporation, Oklahoma City; 396 pages, $2.50.

Aviation Radio

Henry W. Roberts

Contents: Understanding Aviation Radio; Primary Radio Facilities; Advanced Radio Facilities; Radio Navigation; Aviation Radio Apparatus.

The author's purpose in writing this book has been to provide the reader with knowledge of the various branches of aviation radio. The basic principles on which radio communication has been built are explained in language that can be understood by the layman. The essential elements of radio and those facts regarding electricity and electronics on which the comparatively new science rests are discussed. The history of radio is briefly reviewed.

Some of the subjects discussed include the principles of radio direction finding, direction finders, radio ranges and bea-

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cons, communication equipment, advanced radio facilities, the principles of radio navigation, and the design, testing, and servicing of radio apparatus. William Morrow & Company, New York, 1945; 637 pages, $5.00.

Production-Line Technique

Richard Muther

Contents: Line Production; Advantages and Limitations; Methods and Equipment; Movement of Material; Layout; Balance; Installation; Organization and Planning; Materials Control; Production Control; Quality; Maintenance; Personnel; Flexibility; Modifications of Line Production; Problems.

Based on firsthand field investigations of current practices in manufacturing plants, this book explains the fundamentals of production lines, compares these fundamentals with job-lot manufacture, and shows how production lines are set up and operated. The author's aim has been to provide the reader with a clear understanding of the nature, advantages, and limitations of production lines. Steps to follow and pitfalls to avoid in setting up such a line are explained. The reader is provided with a knowledge of how to modify production to meet situations peculiar to certain plants.

The book is divided into four main parts as follows: Part I, Line Production: Its Advantages and Limitations; Part II, Establishing the Line; Part III, Operating the Line; and Part IV, Diversification in Line Production. McGraw-Hill Book Company, Inc., New York, 1944; 320 pages, $3.50.

Cloud and Weather Atlas

Hugh Duncan Grant

Contents: How Clouds are Formed; Cloud Regions and Beyond; Cloud Classification; Heights of Clouds; Movements of the Air—Cyclones and Anticyclones; Air-Mass and Frontal Analysis; The Significance of Clouds for Tomorrow's Weather; Fog and Visibility; Weather Signs and Optical Appearances; Variations of Cloud Color; Cloud Codes and Weather Symbols; World Aspects; Pageant of the Sky—A Summary; Aerial Views of Clouds—Clouds in Flight, by Peter E. Kraght.

This atlas has been prepared for the purpose of aiding observers in the identification of the different cloud formations according to the International System of Classification. It contains 166 photographic reproductions of cloud formations that are identified by family, genus, species, and variety.

Typical cloud formations are analyzed with respect to the weather that can be expected. Information is given about such phenomena as thunderstorms, tornadoes, dust storms, lightning, the Aurora Borealis, and other weather signs and optical appearances. A discussion is given of air masses and frontal analysis.

Numerous charts, diagrams, and tables are included, as well as a compilation of the symbols used by the U.S. Weather Bureau and a typical weather map. Coward-McCann, Inc., New York, 1944; 294 pages, $7.50.

Book Notes

The Dyess Story, by Lt. Col. William E. Dyess, edited by Charles Leavelle; G. P. Putnam's Sons, New York, 1944; 182 pages, $2.00.

The tragic story of the career of Lt. Col. William E. Dyess is edited posthumously as a part of the heroic record of our airmen in the Philippines.

The larger part of the book is devoted to an account of the experiences of prisoners in Japanese camps and during their forced marches. The sufferings of these men were so horrible that without such a reliable account they would seem to be unbelievable.

Colonel Dyess was a gallant pilot and his accidental death was a great loss to the Air Forces. It is fortunate that before his death he related his experiences so that they will always be part of the record of the heroism of our airmen during the early days of the war.

Medicine and the War, edited by William H. Taliaferro; The University of Chicago Press, Chicago, 1944; 193 pages, $2.00.

A series of lectures by specialists in various branches of medical science. Dr. Henry T. Ricketts, Associate Professor of Medicine at the University of Chicago, in a summary of aviation medicine reviews the historical background of aeromedicine and gives the latest developments in high-altitude effects on pilots, anoxia, and speed and acceleration.

International Standardization Report of the United States Aeronautical Standards Mission to Great Britain; National Aircraft Standards Committee of the Aeronautical Chamber of Commerce of America, Inc., and the Society of Automotive Engineers, Inc., New York, 1944; 99 pages.

This report gives the results of discussions between the U.S. Aeronautical Standards Mission and those organizations and firms in England interested in standardization.

The mission held many meetings at which the problems of international standardization were considered. It is evident from the report that progress is being made in a reciprocal exchange of standardization information. The work of the various organizations here and in England which are charged with standardization is outlined. The standardization procedure and policies that relate to materials, processes, and parts are given in detail.

The report is a worthwhile contribution to the consideration of standardization from the international viewpoint.

The Future of Industrial Research; Standard Oil Development Company, New York, 1945; 173 pages.

Research has played such an important part in the progress of aeronautics that the papers presented at a forum organized by the Standard Oil Development Company will be of immediate interest.

The problems of research conducted by the Government, by large and small units of industry, and by universities are all discussed by leaders in the field of scientific investigation. They give answers to some current problems and ask many new questions.

It is of especial interest to those engaged in aeronautical activities that there was general agreement that the National Advisory Committee for Aeronautics had set a pattern that could be used in the future by Government agencies.

Our Fighting Ships, by Mitchell D. Katz, Jr., Herbert C. Lee and Edwin L. Levy, Jr.; Harper & Brothers, New York, 1945; 89 pages, $2.50.

This edition, containing data about the ships of the United States Navy, includes a section on aircraft carriers of all types now in service. The principal characteristics of each type are listed and described.

The Far Shore, by Lt. Comdr. Max Miller; Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1945; 173 pages, $2.50.

One of the most experienced correspondents, who is serving in the Navy, has written an eyewitness story of the invasion of Normandy and Italy, vividly narrating the work of our landing craft and the difficulties they had to overcome. One chapter in the book tells of the author's flight from Ireland to Africa, with a description of Gibraltar.

The illustrations are official Navy and Coast Guard photographs. All royalties from the sale of the book are directed to the Secretary of the Navy for distribution to such naval welfare funds as may be selected.

Economic Implications of Aircraft, by Caroline Isard and Walter Isard; The Quarterly Journal of Economics, New York, 1945; 25 pages.

This reprint from the February, 1945, issue of *The Quarterly Journal of Economics* is a study of the impact of air-transport technology on the national economy of the United States. It reviews the cost of air transport and indicates its role in the future transport structure. The effects of shifting population, investment outlets, export possibilities, and the general concepts of the assistance that must be given to both

national and international air transport are all considered in determining the extent to which the potentialities of aircraft will affect transport economy of the future.

Wings for Peace, by A. Markle; Labour Party Publications Department, London, 1944; 22 pages, 4*d*.

This British publication is one of a series of Labour Party pamphlets. The subject of labor's postwar policy for civil flying is discussed. Consideration is given to the future organization and control of civil flying.

New World of Machines, by Harland Manchester; Random House, New York, 1945; 313 pages, $3.00.

This review of the miracles of modern technical development includes many that have to do with aviation. New fuels, radar, jet propulsion, the helicopter, and other related aeronautical advances are described, with background histories. For a survey of the application of science to industry and personal uses, the book is interesting and informative.

Introduction to Global Geography, by Bernice Baxter and Thad Stevens; Harr Wagner Publishing Company, New York, 1945; 122 pages, $1.92.

The changed attitude toward geography as a result of the airplane is outlined in this book, which shows how to read maps and globes and discusses various old and new projections. The land and water areas are described and their interrelationship is shown. The position of the earth and its movements are explained with observations about weather and climate.

New ideas of distance and direction which have to be considered by airmen are outlined. The presentation of the new global geography is made in nontechnical language and is suitable for students as well as those who wish to review their geography in the light of recent progress.

Civil Air Regulations for A-and-E Mechanics; Aero Publishers, Los Angeles, 1944; 111 pages, $2.50.

This book contains a reprint of a group of the Civil Air Regulations of which knowledge is required by members of the armed forces and others who are applying for C.A.A. certificates for airmen and mechanics. A reproduction of the U.S. Department of Commerce booklet *Pilot Written Examination Guide-book* constitutes Section One, because it contains information useful to those planning to take C.A.A.written examinations for airmen certificates. The other sections include parts of the regulations and amendments applying specifically to the information needed by aircraft mechanics and aircraft-engine mechanics. A list of check questions and an appendix containing the rules for type and production certificates complete the volume.

The Young Officer's Guide to Air Force Law, by F. J. O. Coddington; Gale & Polden, Limited, London, 1944; 154 pages, 2*s*. 6*d*.

This book is essentially a translation into Air Force language of the 15th edition of the author's book titled *Young Officer's Guide to Military Law*. It is intended to provide the junior officer with an understanding of the Air Force law concerned with offenses under military regulations.

Nautical Mathematics and Marine Navigation, by S. A. Walling, J. C. Hill, and C. J. Rees; The Macmillan Company, New York, 1944; 221 pages, $2.75.

This book is designed mainly for those anticipating sea service. It is composed of two distinct parts. The first contains a review of elementary arithmetic and algebraic and geometric principles having nautical pertinence. The second outlines the fundamentals of navigation and shows how the mathematics are applied to the problems of seamanship.

A Survey of Post-War Travel, National Association of Travel Officials, Chicago, 1944; 50 pages, $5.00.

A collection of reports dealing with postwar travel, including air transport. They give the results of a nation-wide survey of the subject which was made to provide a base from which to project future developments in personal transportation.

Five-Figure Logarithm Tables; His Majesty's Stationery Office, London, 1944; 120 pages, 7*s*. 6*d*.

This is a collection of three-component, five-figure tables of logarithms and logarithmic trigonometric functions. It contains (1) Chappell's table of logarithms, giving five-figure logarithms of the numbers 10,000 to 40,000 and 4,000 to 10,000; (2) von Rohr's table of five-figure logarithms of the sines and tangents of the angles 0°.000(0°.001)5°.000; (3) Bremiker's table of five-figure logarithms of sines, tangents, cotangents, and cosines of the angles 0°.00(0°.010)-45°.00. The collection is designed primarily to meet the wartime requirements of the optical industry.

Splicing Wire and Fiber Rope, by Raoul Graumont and John Hensel; Cornell Maritime Press, New York, 1945; 114 pages, $2.00.

Illustrated by drawings and photographs, simple directions are given for executing all types of splices with both fiber and wire rope. Among the operations explained are flexible and nonflexible cable splices used in aircraft cord; eye splices, back splices, tail splices, short and long splices; grommets; and lock tucks in various kinds of eye splices. Instructions for meshing and socketing, information about rigging blocks and tackles, and a glossary of rope terms are included.

National Fire Codes, Vol. I, 1945, compiled by Robert S. Moulton; National Fire Protection Association, Boston, 1945; 591 pages, $3.00.

Superseding the National Fire Codes for Flammable Liquids and Gases, Edition of 1943, this volume incorporates

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Industrial Housekeeping Manual, by R. F. Vincent; National Foremen's Institute, Inc., Deep River, Conn., 1945; 115 pages, $2.50.

Addressed mainly to building managers, supervisors, and cleaning-crew foremen, this handbook offers a guide to the establishment of an adequate "housekeeping" and cleanliness program in plants, factories, and offices. Operating instructions and advised work procedures are reported to be the result of motion and time studies, field experience, discussions with competent representatives of equipment firms, and knowledge of the chemical characteristics of cleansing materials.

Allied and Enemy Aircraft; Gale & Polden, Limited, London, 1944; 56 pages, 2*s*.

A new edition of a pocket guide to the most important American, British, and German aircraft, corrected to July, 1944. It contains silhouettes and brief descriptions of bombers, fighters, and other military aircraft likely to be seen in the western and south European areas.

Plastics Catalog; Plastics Catalogue Corporation, New York, 1945; 1,178 pages, $6.00.

This ninth and expanded edition of the comprehensive Plastics Catalog reviews the plastic industry's wartime advances. The entire contents of the book, including the charts and directory sections, have been revised and made current; the technical section has been augmented to include a compilation of important data on the properties of plastics; and new articles and illustrations have been added.

The text is divided into eleven different sections, an appendix, and a directory. The sections are headed Progress in Plastics; Technical Data; Materials; Engineering Design; Molding, Extruding, and Casting; Fabricating, Finishing, and Assembly; Machinery and Equipment; Laminates, Plywood, and Vulcanized Fiber; Coatings; Synthetic Fibers; Synthetic Rubber and Rubber-Like Plastics.

Attitude, by Jerome Lederer; 17 pages, $0.25.

Electrical Principles, by John W. Stone; 153 pages, $1.25.

Electrical Shop, by John W. Stone; 16 pages, $0.40.

Engine Principles, by James W. Etchison; 233 pages, $1.75.

Flight Crew Training Program; 26 pages, $0.25.

Flight Principles, by Sherman E. Crites; 61 pages, $0.60.

Hydraulic Principles, by James W. Etchison; 98 pages, $1.00.

Instructor's Manual, by Howard K. Morgan; 28 pages, $0.25.

Loading and Cruising, by John J. Ford; 110 pages, $1.00.

Mechanical Principles, by Sherman E. Crites; 66 pages, $0.60.

Mechanics Handbook; 55 pages, $0.60.

Navigation Principles, by Elbert F. Blackburn; 219 pages, $1.75.

Of Instruments and Things, by W. A. Straith and Robert N. Buck; 20 pages, $0.25.

Pilot's Technical Manual, by R. Dixon Speas; 114 pages, $1.50.

Radio Operating, by John W. Stone; 65 pages, $0.60.

Radio Principles, by John W. Stone; 139 pages, $1.00.

Refueling the Airplane, by A. G. Thomas; 28 pages, $0.25.

Stock Clerk's Manual, by Gordon Brock; 90 pages, $1.00.

Use of Numbers, by Howard K. Morgan; 66 pages, $0.60.

Weather Principles, by Peter E. Kraght; The Infantry Journal, Washington, D.C., 1944; 106 pages, $1.00.

This group of 20 manuals was prepared for the instruction of flight and ground crews. They were originally published by the Airlines War Training Institute. In some of these books the question-and-answer method of presentation is used and classroom problems and material for home study are included. Fundamental principles are explained with the aid of charts, diagrams, sketches, and photographs.

Conference Leader Training, by Edward S. Maclin and Paul T. McHenry; National Foremen's Institute, Inc., Deep River, Conn., 1945; 77 pages, $2.50.

A book written for the purpose of furnishing helpful information for those who must conduct conferences. The underlying principles of conference leading are set forth. The authors present in practical form the various devices used in dealing with different situations, as well as the techniques involved in planning and leading a discussion.

Engineering Contracts and Specifications, by Robert W. Abbett; John Wiley & Sons, Inc., New York, 1945; 188 pages, $2.25.

Legal and business aspects of the engineering profession are dealt with in this reference and textbook. Contract procedure is developed along the lines of private practice but attention is directed to matters in which Government procedure differs. One chapter is devoted to a summary of the elements of business law which are significant in contract relationships. Instructions for specification writing are given.

Electrical Drafting, by D. Walter van Gieson; McGraw-Hill Book Company, Inc., New York, 1945; 140 pages, $1.50.

Drafting technique as applied to electric-circuit diagrams and wiring plans is the phase of technical drawing dealt with in this book. The reader is carried by a graded series of drawings, plates, and explanations, from the simple form of electrical diagrams to those that are more complex. It is assumed that the potential electrical draftsman has an elementary knowledge of the electric circuit. A chapter is given to aircraft-wiring plans.

Theorie der Differentialgleichungen (Theory of Differential Equations), by Ludwig Bieberbach; published and distributed in the public interest by authority of the U.S. Alien Property Custodian by Dover Publications, New York, 1944; 399 pages, $3.75.

This is a German book on ordinary and partial differential equations of the first and second order. It is intended for the student who has not gone deeply into the subject of differential equations. Important modern problems in this field are discussed.

The marginal-value problems of ordinary differential equations are presented in a new way, according to the researches of Pruefer. An outline of the Lie Theory and of the Poincaré statement of the asymptotic integration is added to this third edition.

How to Handle Labor Grievances, by John A. Lapp; National Foremen's Institute, Inc., Deep River, Conn., 1945; 293 pages, $4.00.

Plans and procedures for dealing with labor grievances are suggested. The history of the development of grievance plans and problems which have resulted from various established systems are reviewed.

Strength Properties of Yellow Poplar from Virginia, by E. George Stern; reprinted from the *Bulletin of the Virginia Polytechnic Institute,* Engineering Experiment Station Series No. 59, December, 1944; 36 pages.

A report is made of an investigation of the strength properties of yellow poplar, conducted to supplement the available information regarding this variety of wood. The data are based on tests of specimens taken from a selected tree growth in Tazewell County, Va. They are applicable in designing wooden aircraft structures for which information is needed with regard to the performance of the wood under stress. Using the text data given, correlations are feasible of the various stresses and moduli in flexure, in tension parallel to grain, and in compression parallel and perpendicular to grain.

Following a description of the investigation, sections of the article contain statements of the physical properties of the wood, its strength properties, the variations in strength properties within the tree, the correlation of the strength properties, and a summary of the results. Numerical tables and graphs give visual expression to the figures.

A supplementary article by Earle B. Norris, Dean of Engineering, describes the wood research laboratory of the Virginia Polytechnic Institute, at which the tests were conducted.

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Fiction and Juvenile Books

A Yankee Flier in Italy, by Al Avery; Grosset & Dunlap, New York, 1944; 212 pages, $0.60.

This is another Al Avery story of the thrills and adventures of an American, an Irish, and an English pilot who carried through spectacular flights regardless of orders. They are taken prisoner, escape, and engage in two daring rescues near Naples. For those who like hair-raising dare-devil escapades this story will provide an evening's entertainment.

Sky Highways, by Trevor Lloyd; Houghton Mifflin Company, Boston, 1945; 61 pages, $2.50.

The author, Professor of Geography at Dartmouth College, writes of his flight around the world via Africa, China, Siberia, and Alaska. The book follows his diary and tells of his interesting observations of people, cities, and flying technique. Two of the chapters discuss meteorology and map making in terms understandable by lay readers.

By experience, a demonstration is given of the impact of the airplane on geography and world space. Written in nontechnical language, it will be of special interest to young people.

The Men Who Gave Us Wings, by Rose N. Cohen; The Macmillan Company, New York, 1944; 210 pages, $1.08.

Planes for Bob and Andy, by Miriam Blanton Huber, Frank Seely Salisbury, and Arthur I. Gates; The Macmillan Company, New York, 1943; 352 pages, $1.12.

Airplanes at Work, by Gertrude Whipple; The Macmillan Company, New York, 1944; 248 pages, $1.00.

Aviation Science for Boys and Girls, by Charles K. Arey; The Macmillan Company, New York, 1944; 229 pages, $1.12.

This series of four books, designated as "Aviation Readers," is intended to be used in primary schools to acquaint pupils with the art and science of aviation.

The first book is a sketchy history of aeronautics, which contains many of the errors found in popular accounts of the development of balloons and flying machines. It is written for youths and therefore has to be in simple language.

The second of the series is intended to bring the student closer to the actualities of flying and enlarge his vocabulary. It tells the story of two boys who take flying instruction and eventually carry mail and take passengers for short flights.

The third reader describes the work an airplane does. One half of the book is about service aviation, fighting fire from the air, air transport, and aerial photography. The other half is about air fighting over land and sea. Tomorrow's airplanes are sketched briefly.

By the time a pupil has reached the fourth book in the series he is able to absorb more technical aspects of aviation. In understandable words, the principles of flight and its required accessories are stated so that boys and girls can grasp the underlying reasons for the successful operation of an airplane.

The entire series gives a well-rounded approach to flying and will be useful in schools and in home study.

Flight Nurse, by Georgia Craig; Arcadia House, Inc., New York, 1945; 256 pages, $2.00.

This novel gives a fair idea of the life of a flight nurse in the Pacific area. A nurse in a hospital becomes involved in a triangular love affair at Palm Beach. Later, the participants come together in Italy and in the South Pacific. The book will stimulate an interest in the career of a flight nurse and show prospective candidates that the hardships of nursing may have a sidelight of romance.

Jet Plane Mystery, by Roy J. Snell; Wilcox & Follett Company, Chicago, 1944; 244 pages, $1.00.

The scene of this book is the Pacific where the pilot of a Navy scout plane assigned to an aircraft carrier discovers that the enemy has a mysterious plane. After a battle with Jap Zero fighters, the pilot and his radio operator are forced down at sea, reach an island, and discover that the mysterious craft is an American jet-propelled amphibian.

The story tells of romance, cannibals, and jungle life, leading up to the capture of the jet machine.

A Yankee Flier in Normandy, by Al Avery; Grosset & Dunlap, New York, 1945; 209 pages, $0.60.

As each new theater of operations opens books appear using it as a background. This book is the story of a pilot who assists the Maquis before the invasion of Normandy by flying supplies to them. He gets caught in France during the invasion, renders service to the paratroopers by blowing up a bridge, and, by violating orders, rescues pilot friends.

School in the Sky, by Ruth and Latrobe Carroll; The Macmillan Company, New York, 1945; 136 pages, $1.75.

This story for children tells of a trip of eight young pupils, their school teacher, and a cow on an air voyage from the United States to Greenland and the North Pole. From there they flew over Siberia and China to the South Pole, returning home by the way of South America.

Library Accessions

Harrying the Hun, by Norman Demuth; John Crowther Ltd., London, 1941; 120 pages, 1*s.* 3*d.*

A handbook of scouting, stalking, and camouflage. German "trick" tactics and how to combat them are part of the study.

Practical Camouflage, by Norman Demuth; John Crowther Ltd., London, 1942; 72 pages, 1*s.* 3*d.*

A discussion of camouflage techniques and problems as they affect and concern the Home Guard. In dealing with the art of concealment, this booklet concentrates mainly on its static phases.

A Catechism of Air Raid Precautions, Parts 1 and 2, by Norman Hammer; John Bale, Sons & Curnow, Ltd., London, 1939; 5th Edition, 1*s.* 2*d.*, per volume.

Intended especially for first-aid and casualty service volunteers and for air-raid wardens, these two booklets contain advice on air-raid precautions presented in the form of questions and answers. They also include data pertaining to the protection of the civil population in chemical warfare, gas first aid, and the medical and nursing treatment of gas cases. The training and work of A.R.P. casualty services and the general principles of local and industrial schemes for air-raid protection are also covered. The fifth edition offers additional and altered material, especially in connection with the organization and training of A.R.P. services.

Molesworth's Aeronautical Engineers Pocket Book, by Albert Peter Thurston and W. O. Manning; E. & F. N. Spon, Ltd., London, 1942; 321 pages, 10*s.*

A compilation of tables and data useful to those engaged in the design of aircraft and aircraft engines presented in a book small enough to be carried in one's pocket.

The Conduct of A.R.P. Incidents, by T. E. Browne; Jordan & Sons, Ltd., London, 1942; 48 pages, 1*s.*

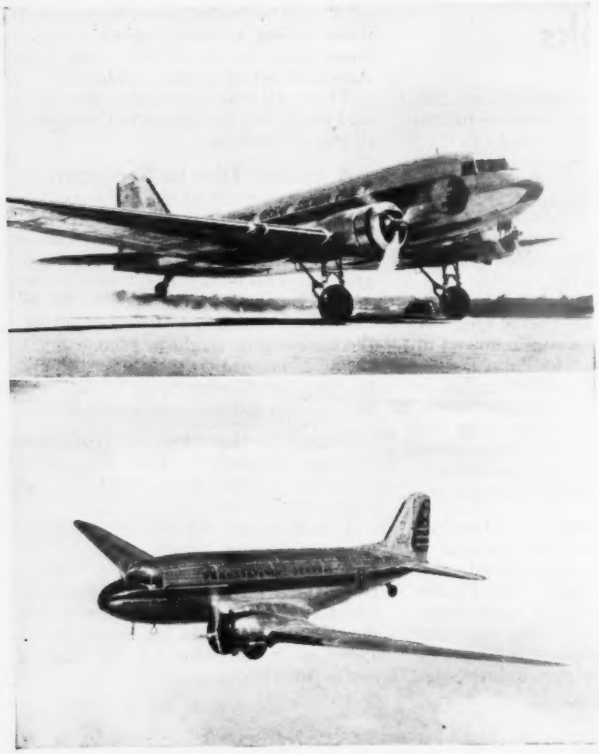
Second edition of a guide for personnel of the civil defense services. Based on practical "blitz" experience, this pamphlet outlines and explains their duties during air raids. It also contains data about the different units and their organization.

American Type Designations, Explaining the System of Naming and Numbering of U.S. Aircraft; Real Photographs Company, Ltd., Southport, England, 1942; 16 pages, 1*s.*

An interpretation of the system of naming and numbering United States aircraft.

The Aircraft Press Tool Maker, by William S. B. Townsend; Sir Isaac Pitman & Sons, Ltd., London, 1942; 75 pages, 5*s.*

Advice is given on how to make different types of press tools for aircraft. Such knowledge is included as will enable a good toolmaker to carry out his own heat-treatments on materials in general.



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The Story of Blossom the Brave Balloon, by E. F. Herbert; Frederick Muller, Ltd., London, 1941; 26 pages, 2*s.* 6*d.*

A "picture book" for very young children.

Aircraft Instruments, Their Construction and Maintenance, by J. Riley; N.A.G. Press Ltd., London, 1942; 74 pages, 1*s.* 6*d.*

A primer describing the functions of various aircraft instruments, fundamental principles of their design and calibration, and methods of maintenance. It takes into consideration the altimeter, air-speed indicator; rate-of-climb indicator; gyroscope; directional gyro; turn-and-bank indicator; artificial horizon; longitudinal clinometer; boost gage; and tachometer. There are also sections on the electrical engine-speed indicator; transmitting radiator thermometer; oil-temperature thermometer; transmitting air temperature thermometer; engine-cylinder thermometer; oil-pressure gage; transmitting fuel-pressure gage; fuel-contents gage; electrical fuel-contents gage; undercarriage-position indicator; magnetic compass; and others.

Camouflage Simply Explained, by Lt. Col. Cyril H. Smith; Sir Isaac Pitman & Sons, Ltd., London, 1942; 32 pages, 9*d.*

Principles of concealment methods are explained in elementary terms. The manual was designed as a guide for British Home Guard and A.T.C. personnel.

Air Training Mathematics, by I. R. Vesselo; Sir Isaac Pitman & Sons, Ltd., London, 1942; 44 pages, 9*d.*

Written to meet the needs of those who wish to train for air crew or ground staff duties, this booklet contains exercises in the required mathematics. It includes some arithmetic, algebra, geometry, and a little navigation.

Sequence of Flying Instruction, 1938; Canadian Department of Transport, Civil Aviation Division, Ottawa, 1940; 44 pages.

As reprinted from outlined R.C.A.F. procedure, these notes have been compiled as a simple and concise form for flight instructors to follow in teaching fundamental principles of maneuver and control. The advised sequence is divided into 27 lessons, each supplemented by explanatory notes and hints on demonstration.

Vozdushnyi Parad (Air Parade), by E. Tarakhovskaia; Detizdat, Moscow, 1937; 8 pages.

Written in verse, this is an illustrated booklet for children about airplanes.

Employment and Earnings in the Engineering Profession, 1929 to 1934, by Andrew Fraser, Jr., under the direction of A. F. Hinrichs; U.S. Department of Labor, Bureau of Labor Statistics, Bulletin No. 682; U.S. Government Printing Office, Washington, D.C., 1941; 235 pages, $0.25.

Prepared at the request of the American Engineering Council, this report deals with the changes in employment opportunity and income within the engineering profession during the years from 1929 to 1934. Effects of the depression upon professional engineers during that period are indicated. The basis for the report is information collected in 1935 by the Bureau of Labor Statistics.

The Construction and Calibration of the V.P.I. Wind Tunnel, by Norval White Conner; Bulletin No. 29, Engineering Experiment Station, Virginia Polytechnic Institute, Blacksburg, Va., 1937; 32 pages, $0.20.

Descriptive data and specifications relative to the construction and capacity of the wind tunnel at Virginia Polytechnic Institute are offered not only as a guide for the construction of similar tunnels but also to acquaint engineers and industries with wind-tunnel facilities available for research on aerodynamic problems. The results of tests made upon standard geometric forms are reported and the turbulence is compared with that of tunnels belonging to other aerodynamic laboratories.

Air of Glory, A Wartime Scrapbook, by Cecil Beaton; British Information Services, New York, 1941; 88 pages, $1.75.

A collection of photographs depicting various aspects of the wartime scene.

The Nature of Modern Warfare, by Cyril Falls; Methuen and Company, Ltd., London, 1941; 2nd Edition, 101 pages, 4*s.*

Four of the five chapters in this book are the Lees Knowles Lectures given at Cambridge University in 1941. The subjects dealt with are the doctrine of total war, the mechanized attack, tactics of defense, and strategy. The fifth chapter contains notes on mountain warfare.

The Pilot's Book on Elementary Aero-Engines, by H. C. Russell; George Allen & Unwin Ltd., London, 1942; 73 pages, 2*s.* 6*d.*

Elementary principles of aircraft engines are outlined. The book contains informative details regarding the construction and operating principles of the four-stroke internal-combustion engine; lubrication, carburation, and magneto ignition of aircraft engines; and the running and maintenance of the engine. A table for helping to locate the causes of engine faults is included.

The Pilot's Book on Advanced Flying, by Capt. Norman Macmillan; George Allen & Unwin Ltd., London, 1942; 72 pages, 2*s.* 6*d.*

Advice is given on the basic techniques of actual flying from the pilot's point of view. Various phases of the subject are particularized under the following chapter headings: flying fighter; flying multiengined airplanes; flying on one engine; safety factors; forces in flight; the effect of maneuvers; taking off; the stall; landings and undercarriages.

Turning and Screw-Cutting, by W. F. Watson and W. Pitt; Pitt's Popular Publications, Aston Clinton, England, 1942; Revised Edition, 82 pages, 2*s.*

This workshop manual on the techniques of turning and screw cutting is a revised and enlarged edition of two preceding books—*Tips for Turners* and *The New Turner's Handbook.*

Fighting Lights, by John E. Cross; Williams & Norgate Ltd., London, 1942; 67 pages, 1*s.* 6*d.*

A record of the author's experiences with the "searchlight men" of the Royal Artillery. The living and working conditions of the men in this branch of the Army are depicted.

Engineering Workshop Manual, 10th Edition, by E. Pull; The Technical Press Ltd., London, 1943; 294 pages, 6*s.*

Tenth edition of a standard handbook on workshop practises and processes. In this edition, a new chapter has been added on "Tube and Strip Metal Bending," together with several additional pages on a variety of other pertinent subjects.

The Air Cadet's Handbook on How to Pilot an Aeroplane, by Capt. Norman Macmillan; George Allen & Unwin Ltd., London, 1942; 110 pages, 2*s.* 6*d.*

The various controls of the airplane, their functions, and operation are explained in this manual. Advice is also given on how to handle an airplane in different elementary and advanced flight maneuvers.

The Observer's Book on Radio Navigation, by W. J. D. Allan; George Allen & Unwin Ltd., London, 1942; 111 pages, 2*s.* 6*d.*

Second edition of a book outlining the principles of radio navigation. Although the book is concerned mainly with the navigational side of radio, it also deals briefly with the electrical side. Numerous line drawings illustrate the text.

Maps and Elementary Meteorology for Airmen, by W. Myerscough; Sir Isaac Pitman & Sons, Ltd., London, 1942; 60 pages, 3*s.* 6*d.*

This navigational text attempts to take the airmen who have completed their elementary training in the Air Training Corps through the more advanced requirements of the Initial Training Wing. It is divided into three sections: one dealing with maps, the second with meteorology, and the third with the magnetic compass.

D/F Handbook for Wireless Operators, 2nd Edition, by W. E. Crook; Sir Isaac Pitman & Sons, Ltd., London, 1942; 85 pages, 3*s.* 6*d.*

This manual on the principles of direction-finding apparatus has been revised to include the interests of the aircraft wireless operator. The revision consists of a new chapter dealing only with the operation of direction-finding equipment installed in aircraft.

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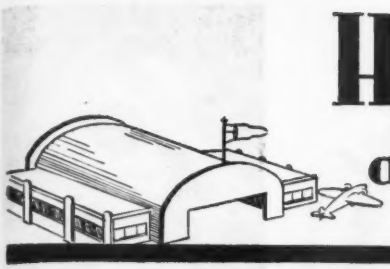

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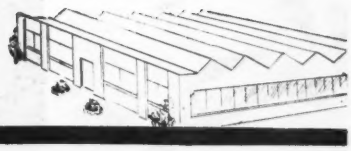

Progress Sponsored by C.A.A. in 1944

The CAA Sets the Stage. T. P. Wright. The Administrator of Civil Aeronautics reports on some of the aviation progress that has been sponsored by the C.A.A. during 1944 and tells what the organization is doing to promote postwar aviation activity. He discusses C.A.A. activities and achievements with regard to the postwar airport program, simplification of regulations, radio improvements, formulation of technical standards, advances in the field of technical research, aviation personnel training, and assisting the development of aviation education. *Trade Winds,* February, 1945.

Cam Slotter

Competition Evolves a Cam Slotter. Information is given about a new method of slotting engine-hood-cowling follower cams. This method is reported to have reduced the time required for the operation from 6 min. to 50 sec. and necessitates the services of but one unskilled operator. As related, the first stage in the evolution of this method was the development of a hand mill and dividing head to mill one slot at a time in the cam follower; the second was a system involving two drill heads and a vertical shaper; the third, a precision boring machine; and the fourth, a double-end centering machine. *The Martin Star,* March, 1945.

Data on Aircraft Fires

Fires in Airline Accidents. This is a report of a study of air-line accidents in which the aircraft was damaged or destroyed by fire or in which fire was involved. Both domestic and foreign American-flag lines, as well as scheduled and nonscheduled air-line operation, are included in the study, which covers the period from 1938 to the first half of 1944. Information is given regarding the numbers of each type of accident, number of persons involved, fatalities, survivors, where the fire started, the causes of the accidents, etc. *Aero Insurance Underwriters,* New York.

Products for the Aeronautical Industry

Goodyear Aviation Products is issued in two volumes. Volume I gives information about tires, tubes, wheels, and brakes for airplanes. In an introduction a brief review is given of the progress of aviation, with notes on the contributions by the manufacturer of these products. Chapters follow containing detailed descriptions of the different types of wheels and brakes for aircraft use, as well as descriptions and illustrations of the numerous styles of tires and inner tubes designed specifically for the landing gear of airplanes. Tables contain specifications and technical data.

In Volume II fuel and oil cells, hose, packing and seals, engine products, and aircraft accessories are described. It includes the research and manufacturing facilities engaged in the development and production of these items and contains illustrations of parts of the plants and detailed descriptions and illustrations of the individual products. *The Goodyear Tire & Rubber Company, Inc.*

Thread-Grinding Booklet

Bulletin No. M-100-145 gives information about the quick and accurate grinding of threads and forms with the multiform wheel on the Sheffield Precision thread and form grinder. It explains the uses of precision thread grinding, outlines the many types of work for which the method is suitable, and gives detailed descriptions of the particular processes involved. The operation of each of the principal elements of the machine is described in full. *The Sheffield Corporation,* Dayton, Ohio.

Explanation of the Gasoline Engine

Enginology. The second edition of this booklet outlining the fundamentals of the operation of the internal-combustion engine has been enlarged and rearranged. It begins with an explanation of the elements of the gasoline engine, defines the various types, and explains in simple terms the functions of the various parts of the engine and how they are coordinated. Separate sections describe the piston and cylinder, the ignition system, the fuel system, and other major components. The study not only includes fundamentals upon which all internal-combustion engines operate but particularly deals with the air-cooled, radial aircraft engine and its characteristics.

Sections are added to explain the function of the propeller and the forces that make the airplane fly. The book concludes with lists of American and British military aircraft equipped with Wright engines, lists of air lines, a brief glossary of aeronautical terms, and pictures of American military and commercial aircraft powered by Wright engines. *Wright Aeronautical Corporation.*

British Aircraft Achievements

A Story of Achievement. A 4-page folder illustrated in color gives a brief review of the accomplishments of the British aircraft industry in the design and production of military aircraft. It pays tribute to the design engineers and manufacturing organizations that contributed to the success achieved by British aircraft in the war. *The Society of British Aircraft Constructors.*

Designing a Military Transport Airplane

Engineering the Packet. George W. Lescher. The various stages of the initial engineering development of the XC-82 are outlined. Special problems involved in the design of this military transport are indicated and the solutions found for them are explained. *The Pegasus,* April, 1945.

Technical Notes on Glues

Manufacture of Aerolite Glues, a 6-page technical bulletin, reviews the history of the manufacture of these glues. It outlines the raw materials, describes the processes of production, and includes sketches and descriptions of the apparatus used and the steps taken to control the quality of the finished product. *Bulletin No. 27,* March, 1945, *Aero Research Limited,* Duxford, Cambridge, England.

Index of Chemical Material Specifications

Cross-Index of Chemically Equivalent Specifications and Identification Code. This book contains specifications of the chemical content of ferrous and nonferrous metals and alloys. The specifications are classified on the basis of the chemical composition of the material. Each specification carries a code or group number that is common to all other specifications for material of similar chemical composition.

In this second edition the information is divided into three parts and an appendix. In Part I the groups of specifications for material of similar chemical compositions are arranged in the numerical order of the code number assigned to each group of such specifications.

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STRENGTH	GOOD	GOOD	HIGH	HIGH	GOOD	GOOD	HIGH	GOOD
TOUGHNESS	GOOD	GOOD	HIGH	GOOD	GOOD	HIGH	HIGH	HIGH
HARDNESS	GOOD	GOOD	GOOD	GOOD	HIGH	FAIR	HIGH	GOOD
MACHINABILITY	GOOD	HIGH	GOOD	HIGH	GOOD	GOOD	GOOD	GOOD
NON-GALLING	NO	NO	NO	NO	HIGH	NO	NO	NO
SPRING PROPERTIES	GOOD	NO	HIGH	NO	NO	GOOD	HIGH	HIGH
ELEC. CONDUCTIVITY	POOR	POOR	POOR	POOR	POOR	GOOD	GOOD	POOR
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specification; and (4) the detailed chemical composition of the material required.

In Part II the specifications for ferrous and nonferrous metals and alloys of the Government agencies and manufacturing organizations reported in the publication are listed. The specifications issued by each such agency are listed separately, in alphabetical or numerical order.

In Part III the code numbers are listed in numerical order with their nominal composition expressed as percentages of the various elements. The appendix contains miscellaneous data including a list of abbreviations and their meanings, a summation of the notes used, a list of names of various alloys, and the code number groups where such alloys are found. The book has been prepared at the request of the United States armed forces and is published and distributed by *General Motors Corporation.*

Laboratory and Factory Tests for Magneto Coils

Testing Magneto Coils. N. Rohats. This article describes two types of high-potential equipment used for testing the coils used in aircraft magnetos. One is for the inspection of magneto coils and the other for testing the life of the coils.

Each makes use of suitable electronic circuits to induce in the coil a voltage having a wave shape and frequency approximately similar to that of the voltage induced in service. A detailed description is given of the machines, which are called, respectively, the inspection tester and the life tester. The text is clarified by circuit diagrams and illustrations. *General Electric Review*, March, 1945.

The Functions of the Propeller

Propeller Theory is a 32-page illustrated booklet divided into two parts. Part I gives nontechnical explanations of how the screw propeller operates and the theory on which it is based. Illustrations show the forces to which the propeller is subjected. Part II deals with the more recent development of constant-speed and counterrotating propellers and their application in aiding the performance of aircraft. A detailed description is given of the Curtiss electric propeller and its control equipment. *Curtiss-Wright Corporation, Propeller Division.*

Aircraft Built by a Tire Company's Subsidiary

Goodyear Air Craftsmanship is the title of an illustrated booklet showing how a leading manufacturer of tires has become one of America's important aircraft manufacturers, building complete airplanes, airships, and major airplane components for the Army, Navy, and Marine air forces. The pages contain colored pictures and brief descriptions of the Corsair, B-29 Superfortress, P-61 Black Widow, B-26 Marauder, F6F Hellcat, PB2Y Coronado, P-38 Lightning, TBF Avenger, P-40 Warhawk, PBM Mariner, B-24 Liberator, PB Ventura, and the lighter-than-air craft, all or parts of which are made by the Goodyear organization. *Goodyear Aircraft Corporation.*

Electric Timer Bulletin

Bulletin No. 1100 describes table-model stop clocks, wall-model stop clocks, precision chronoscopes, combination timers and impulse counters, stopwatch controllers, and spring-wound X-ray timers. These timers are made for application in industrial and laboratory testing, such as in measuring start-to-stop intervals of relays and instruments and for checking sequence operations.

Circuit diagrams are included to show correct methods of connecting the various timers in test circuits. *C. H. Stoelting Company*, Chicago.

Heating Equipment

This 4-page folder describes aircraft heaters of capacities ranging from 15,000 to 100,000 B.t.u. per hour and automotive type heaters from 15,000 to 40,000 B.t.u. per hour. The folder, illustrated in three colors and designated as Form SH-2, shows cutaway views of the heaters and gives specifications of all models. It also explains a new combustion process known as vapor entraining. *Anchor Post Fence Company, Fluid Heat Division*, Baltimore.

Postwar Problems

Production Management and How It Affects Productivity, Costs, and Employment investigates the questions involved in postwar employment matters. It outlines procedures and policies helpful in the attainment of satisfactory employment conditions, based on experiences in more than 1,000 plants. Sections are divided into work measurement, method improvement, labor cost and expense control, production control, job evaluation, incentive wage plans for production workers, indirect workers and supervisors, and labor's attitude toward increased productive efficiency. The booklet contains 40 pages, including 12 pages of pictorial diagrams and charts. *Albert Ramond and Associates, Inc.*, New York.

Mathematics for Aircraft Design

Analytic Geometry Applied to Aircraft Layout. John C. Dippenworth. The purpose of this article is to describe rapid, precise, and efficient methods of solving aircraft design problems by the use of analytic geometry. It outlines the type of problems that may be solved accurately by the analytic method in a minimum of time and with a saving of layout space. The applications are defined and the methods are explained.

The author describes the difference between analytic and descriptive methods of determining contours and then includes practical problems in airplane-wing designs, giving detailed explanations of each step in the solution of the problem. *Technograph* (The Glenn L. Martin Company Engineering Educational Program), January, 1945.

Catalog of Ceramics

AlSiMag Ceramics for Electrical and Other Technical Uses gives information about the production and use of technical ceramic materials for a wide variety of uses in the electrical, thermal, chemical, and mechanical industries. It describes and illustrates these products and indicates their uses. Tables give the mechanical and electrical properties of the different products. *Bulletin No. 444, American Lava Corporation*, Chattanooga, Tenn.

Oil-Refining Equipment

Oil Refining . . . Engineering to New Precision Standards. An illustrated booklet of 32 pages contains descriptions of modern processes of refining petroleum. Its sections define the processes of fluid catalytic-cracking, alkylation and isomerization, hydroforming, polymerization, and basic processes and equipment. Other pages give the details of refining lubricating oil and show diagrams of chemical processes and plant layouts.

Chapters are devoted to the work of the engineer-contractor and the facilities offered by organizations that render engineering and contracting services. *The M. W. Kellogg Company*, New York.

Applications of Induction Heating

Induction Heating and Melting in Industry is divided into four sections describing induction-heating equipment and applications of such processes. The first section gives a history and description of the induction heating process; the second refers to apparatus and methods used in heating; the third tells about induction melting; and the fourth includes detailed descriptions of Ajax-Northrup equipment for induction heating and melting. *Bulletin No. 25, Ajax Electrothermic Corporation*, Trenton, N.J.

ANOTHER MARTIN FIRST!

It's simple to dimple hard and brittle sheet metal with the Martin Spin Dimpler. Adaptable to any drill press capable of 15,000 R.P.M., the new tool may be used by semi-skilled or even unskilled workers.

Putting Dimples in Tough Faces

. . . with the new Martin Spin Dimpler!

NO problem, now, is the dimpling of hard and brittle sheet metals, such as Reynolds 301-T, Alcoa 75-ST and the magnesium alloys. Thanks to a new Martin tool . . . the Spin Dimpler . . . these metals are being dimpled as quickly and easily as softer alloys.

The Spin Dimpler has been used at the Glenn L. Martin Co. to form 100 degree dimples for 3/32, 1/8, 5/32 and 3/16 diameter rivets in both aluminum and magnesium alloys varying from .020 to .064 in thickness. In the case of aluminum, a lubricant . . . Tycol-655 . . . is used.

A product of Martin Engineering, the new tool forms dimples by spinning rather than by pressing them into shape. Trimmer cutting edges remove any metal which is extruded upward and a pressure pad assembly holds sheet in place during the process. Dimples feature a sharp edge, leaving no void around the rivet head, and resist corrosion as well as do machine counter-sunk holes. The Spin Dimpler is now being manufactured, under license, by Topflight Tool Co., Towson 4, Md. and Schaefer Machine Co., Inc., 100 White St., Brooklyn 6, N. Y.

THE GLENN L. MARTIN COMPANY, BALTIMORE 3, MD.
GLENN L. MARTIN-NEBRASKA COMPANY—OMAHA

Wait a Minute, Mister!

Before you turn the page, think! Our fighting men are 100% in this war—and we're only putting 10% of our incomes into War Bonds! Isn't it time you bought an *extra* War Bond? Keep faith with your fighters and yourself . . . buy War Bonds for keeps!

Martin AIRCRAFT

Builders of Dependable Aircraft Since 1909

Equipment for Aerial Photography

Photogrammetric Equipment. Details are given in an illustrated booklet about a wide variety of equipment for aerial photography. Descriptions and specifications of mapping cameras, printers, intervalometers, timers, stereoscopes, contour finders, height finders, triangulators, plotters, and other equipment are included, together with information concerning their uses. *Abrams Instrument Company*, Lansing, Mich.

Control and Measuring Instruments

Bulletin GEA 4363 describes thickness gages, types A, B, and C, for measuring the thickness for nonmagnetic materials. It outlines five typical applications, gives information about the selection of the proper type of gage, and contains detailed descriptions and specifications of the three types of gages.

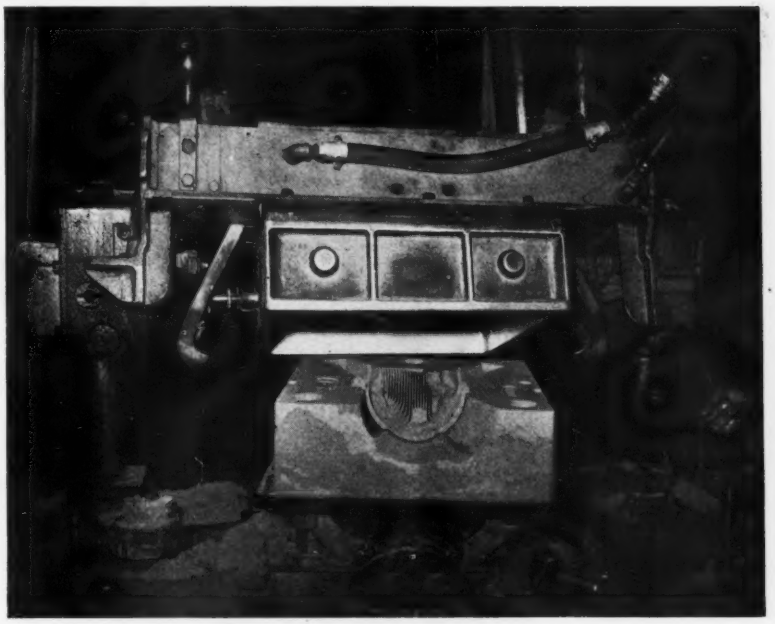
Bulletin GEA 4254 describes push-button units, selecting switches, and indicating lights for built-in machine-tool applications. It shows the purpose for which the different models are suitable, describes the construction, and contains detailed dimensions and drawings, as well as photographs. *General Electric Company.*

Aircraft Service Booklet

The Distribution and Servicing of Aircraft, Aircraft Parts, Supplies and Equipment describes the functions of airport service or "fixed-base" operators. These individuals or firms are located at airports and are engaged in the business of retailing and servicing airplanes and airplane parts, supplies, and equipment to owners of private and commercial airplanes. They also perform a variety of services, such as flight instruction, technical and mechanical instruction, charter service, airplane rental, hangar rental, airport management, crop dusting, contract hauling, aerial advertising, and other activities. The booklet contains information about these activities, with suggestions for the successful operation of that kind of business. Statistics are included in text, maps, and charts showing the potential market for such services. *Aviation Maintenance Magazine*, New York.

S.A.E. Aeronautical Recommended Practices

Preservation and Packaging of Aircraft Engine Parts is the subject of *ARP No. 197A*. The recommendations contained in this booklet represent the current practices employed by the aircraft and engine industry in the packaging of engine parts and assemblies. In the different sections detailed recommendations are made for cleaning, preservation and wrapping, dehydration, inner boxing, or cartonizing, exterior boxing, and markings. A table of materials and a chart of preservation and packaging methods are included, as well as photographs showing examples of current methods of packaging aircraft and engine components. *Society of Automotive Engineers, Inc.*, New York.



An aircraft-engine cylinder core emerges from one of the batteries of a core-making machine in the Buick Motor Division of General Motors Corporation.

War Work of an Automobile Builder

Buick at Its Battle Stations is the title of an elaborately illustrated booklet giving the story of the production of war materials by a large prewar manufacturer of automobiles. The biggest war job is stated to be the production of Pratt & Whitney aircraft engines. Figures are given for the total output of these engines in units and aggregate horsepower, together with numerous illustrations of the plant interiors and close-up views of various engine components in process of manufacture.

Other sections of the book show how the plants are manufacturing the Hellcat tank, steel shell cases, Diesel engines, and 20-mm. ammunition. Information is given about the application of modern metal technology to war production. *Buick Motor Division, General Motors Corporation.*

Aircraft Tools

C-B Aircraft Tools. A 6-page folder contains illustrations and brief descriptions of numerous tools for aircraft production and maintenance. Metal shrinkers, hole punches, metal cutters, rivet cutters, metal crimpers, joggling blocks, and cable-splicing blocks are featured. A 1-page section describes valve-guide cleaners. *C-B Tool Company*, Lancaster, Pa.

Postwar Business Opportunities

Why You Should Be an Aeronca Dealer is a colored brochure outlining the opportunities for postwar retail sales and service business in private aircraft. In addition to describing how an airplane dealership should be established and operated, the booklet gives brief descriptions, specifications, and illustrations of the private aircraft planned by the manufacturer for postwar production. *Aeronca Aircraft Corporation.*

Lessons in Welding

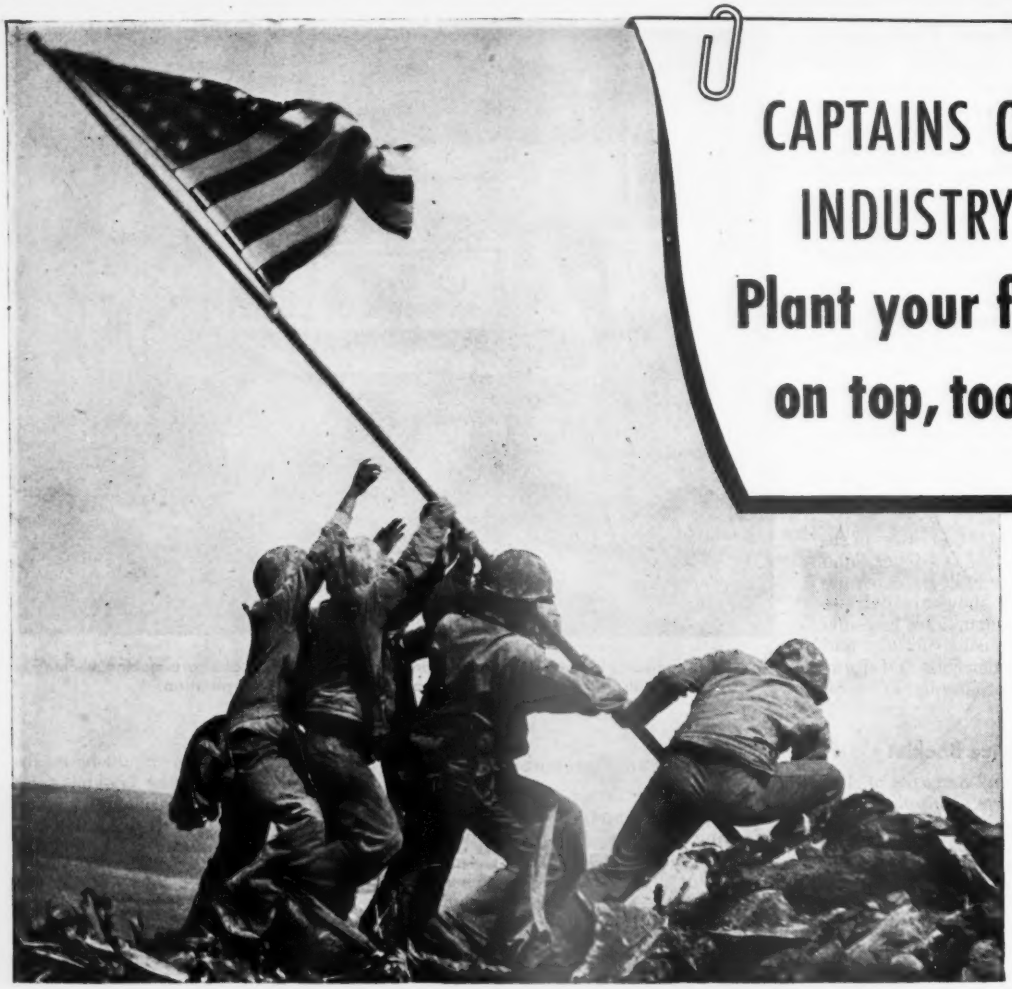
Resistance Welding Control. Seven booklets contain the material for a training course in the theory and application of resistance-welding control. The course includes slide films with sound, a question book, and an instructor's manual.

Subjects included in the course are as follows: Part One, Basic Definitions of Welding Technology; Part Two, Types of Resistance Welding Work; Part Three, The Ignitron and the Thyratron; Part Four, How the Flow of Resistance Welding Current Is Started and Stopped; Part Five, How the Amount of Resistance Welding Current Is Controlled; Part Six, Electronic Timing Controls in Resistance Welding; Part Seven, Energy-Storage Control.

The books are priced at $0.20 each. For a class of 20 students, a complete set of booklets and supplemental material is supplied at $50. *Westinghouse Electric & Manufacturing Company.*

Screw Fasteners

Stalock Self-Locking Fasteners are described in a colored booklet showing the construction and operating principles of a new type of one-piece sheet-metal self-locking fastener. The pages contain photographs, drawings, and specifications of fasteners for numerous applications such as flat nuts, angle brack-



CAPTAINS OF INDUSTRY
Plant your flag on top, too!

This year we've got to make 2=3! This year we've got to make 2=3! We've got to lend Uncle Sam in 2 chunks almost as much as we lent last year in 3. Which means that, in the approaching 7th War Loan, each of us is expected to buy a BIGGER share of extra bonds.

The 27 million smart Americans on the Payroll Savings Plan are getting a headstart! Starting right now they are boosting their allotments for April, May and June—so that they can buy *more* bonds, and spread their buying over *more* pay checks.

Our Marines went over-the-top at Iwo Jima in the greatest, and hardest, battle in the Corps' history. Now it's *your* turn! Your quota in the 7th is needed to help finish this war, sidetrack inflation, build prosperity. So, captains of industry, plant your flag on top—like the Marines at Iwo Jima!

★

CAPTAINS of INDUSTRY—here's your *Check List* for a successful plant drive:

- ★ **Get your copy of the "7th War Loan Company Quotas" from your local War Finance Chairman. Study it!**
- ★ **Determine *your* quota in E Bonds—the backbone of every War Loan.**
- ★ **Arrange for plant-wide showings of "Mr. & Mrs. America"—the new Treasury film.**
- ★ **Distribute "How to Get There"—a new War Finance Division booklet explaining the benefits of War Bonds.**
- ★ **Circulate envelopes for keeping bonds safe.**
- ★ **Display 7th War Loan posters at strategic points.**
- ★ **And—see that a bench-to-bench, office-to-office 7th War Loan canvass is made.**

★

The Treasury Department acknowledges with appreciation the publication of this message by

Aeronautical Engineering Review

★ *This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council* ★

ets, clips, strips, and studs. The manufacturer states that the fastener gives 360° of tensioned thread engagement on either machine or sheet-metal screws. They can be removed intact and installed again, the locking power remaining because the locking bridge has both "ends" firmly anchored. *Adel Precision Products Corporation*, Burbank, Calif.

Electrode Chart

Comparison Chart of Welding Electrodes contains a tabulation of the properties of electrodes supplied by 22 different manufacturers. The 8-page bulletin includes information about stainless steel and hard-surfacing electrodes, as well as the mild-steel type. A section is devoted to a typical weld-deposit analysis of stainless-steel electrodes, showing the percentages of chromium, nickel, carbon, columbium, and molybdenum. The bulletin is numbered *B6344A*. *Allis-Chalmers Manufacturing Company*, Milwaukee.

Cowl-Fastener Instruction Books

Camloc Cowl Fastener Instruction Books Numbers 44A and 44B of the 4002 Series contain descriptions, specifications, and instructions for using these types of fasteners. *Booklet No. 44A* shows the construction of the stud assembly, the grommet, and the receptacle and describes the features that contribute to the rapid installation and operation of these devices. It contains illustrations and specifications of the various types and parts. *Booklet No. 44B* gives detailed instructions for the installation of the fasteners. *Manual No. 44C* contains illustrated service instructions. *Camloc Fastener Corporation*, New York.

Motor Applications

Fractional Horsepower Motor Selector is intended to provide design engineers and production executives with a method for selecting the correct type and size of fractional-horsepower motor for any application. The information is presented in outline style, giving the comparative characteristics of various types of motors and telling how to decide on horsepower, duty cycle, and speed. In addition, it explains control equipment for certain applications and includes a questionnaire form prepared to aid in initiating the design and development work essential to the power equipment for new products. *The Dumore Company, Motor Division*, Racine, Wis.

Manufacturing Facilities Described

The Lights' Beam is a ring-bound booklet containing descriptions and illustrations of the various devices and products of a California manufacturer of electric lighting and control equipment for aircraft, airports, and other uses. It gives brief descriptions of the products and manufacturing facilities, as well as biographic sketches of the heads of the various divisions. *Lights, Inc.*, Alhambra, Calif.

Test Cell Soundproofing

Sound Control for Industry is the title of a booklet on the soundproofing of aircraft-engine test cells. Particulars are given about "Soundstone," a special lightweight block or flat slab unit made of an $^{8}/_{16}$ mesh aggregate of Portland cement, which has been developed for soundproofing. Typical applications of Soundstone for the soundproofing of aircraft-engine test cells are illustrated. Charts show the results of sound and frequency tests made on engine production test cells. Plans for test cell layouts also are shown. "Soundmetal" acoustical baffles also are described. *Homestead Industrial Sound Control*, Hartford, Conn.

S.A.E. Aeronautical Information Report

Testing of Aircraft Engine Carburetors constitutes SAE Aeronautical Information Report No. 11. It consolidates information concerning uniform carburetor-test procedure for obtaining and analyzing flight data about carburetion. The report is in two parts: the first relates to laboratory-test procedure; the second, to flight-test procedure.

The laboratory-test procedure is divided into sections referring to the testing of aircraft carburetors at the plants of the carburetor manufacturers and at the plants of the engine manufacturers. The second section deals with carburetion testing during full-scale nacelle tests conducted by airplane manufacturers. The equipment used, the methods followed, and the results are given in full.

The flight-test procedure contains sections on the instrumentation, flight plans, the presentation and evaluation of results, and a compilation of the engine data to be supplied before the test is made. *Society of Automotive Engineers, Inc.*, New York.

Operations Department Changed

Operations Reorganized. An account is given of changes that have been made in the organization of American Airlines' Operations Department. A chart illustrates the new setup. *Flagship World*, March-April, 1945.

Processed Sheet Metals

Rigidized Metals for Strength, Utility, Texture. An illustrated booklet of 12 pages gives detailed descriptions of sheet metal so formed as to provide increased strength and other properties through the redistribution of stress. Explanations are included of how ferrous and nonferrous sheet and strip can be formed to increase their mechanical strength values.

The booklet contains tabulated specifications and numerous illustrations of patterns in which the metal is supplied and uses to which it is applied. This type of design-strengthened sheet was developed in cooperation with The Glenn L. Martin Company and is planned for general sales and use. *Rigid-Tex Corporation*, Buffalo, N.Y.

Hydraulic-Press Applications

The HPM Hydraulic Press is an extensively illustrated booklet describing the construction and application of hydraulic processes in numerous industries. One featured application is in forming parts for turbosuperchargers. *The Hydraulic Press Manufacturing Company*, Mount Gilead, Ohio.

Facilities of a Manufacturer

The Story of Trane. The major part of the current issue of this house organ is devoted to an illustrated history of the Trane Company and its personnel and a description of its plant facilities. It includes information about the manufacturing process, products, and heat transfer equipment. *Trane Weather Magic*, March, 1945.

Helicopter Market Survey

Survey on U. S. Market for Helicopters. A report has been issued regarding a survey that was conducted in the Fall of 1944 for the purpose of finding out to what degree the helicopter will be a factor in the private aircraft market after the war, its advantages and disadvantages, the number that might be sold, and the probable price, etc. A sample of the questionnaire that was distributed to aviation publications and aircraft companies is shown. Conclusions resulting from the survey are listed. *Esquire Research Department, Esquire Magazine*, New York.

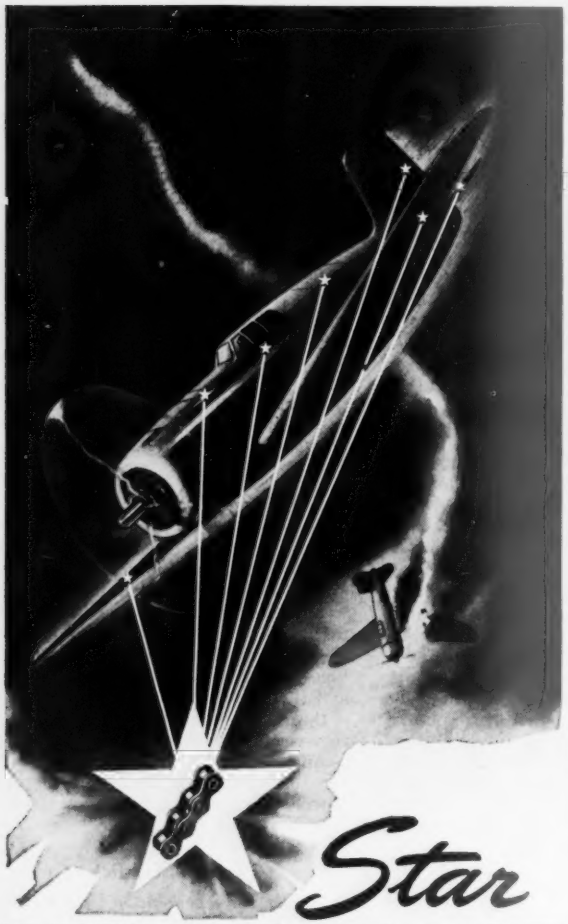
Freight Statistics

Freight Transport in the United States . . . Prewar, War, and Postwar. P. Harvey Middleton. This book of 98 pages gives facts and figures concerning the transportation of freight by railway, highway, and waterway and reports a study of the postwar prospects of commercial aviation. The chapters contain text and statistics regarding the volume of railway freight; national income and postwar traffic; and transportation of agricultural products and products of the forests, mines, and manufactures.

The chapter on air transportation deals with public aid, Government regulation, commercial aviation, operating expenses, estimated rates, and other factors. The appendix contains statistical tables giving figures on freight movements for a period of years up to and including 1943. *Railway Business Association*, Chicago, March, 1945.

Production and Maintenance Suggestions

The Bellringer, March, 1945. (1) A five-stage die reduces operating time in forming holes for Dzus fasteners and combines five operations in one; (2) a wing-bolt torque wrench adapter combined with a conversion chart for adjusting torque readings speeds tightening of bolts and reduces element of inaccuracy in obtaining specified amount of torque; (3) extruder for sealing compound reduces by 60 per cent the time required to use the compound for fire-



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PERFORMANCE

Yes, star performance at every point. For every one of those stars represents an important control point whose operation is governed and co-ordinated by Baldwin-Rex roller chain belts. The positive grip of these chain belts on sprocket teeth insures split-second accuracy . . . instantaneous response to the command of the crew. Impervious to temperature and atmospheric pressure extremes and highly shock absorbent, Baldwin-Rex roller chain belts and terminals operate at as many as 39 important control points, among them such points as:

Ailerons	Bomb Bay Doors	Automatic Flight Control
Wing Flaps	Tail Wheel Doors	Arresting Hook
Rudders	Nose Wheel Doors	Retractable Landing Gear
Elevators	Sliding Hood	Control Column

For complete information on high strength to low weight ratio, Baldwin-Rex roller chain belts and terminals, and valuable information on airplane chain selection and arrangement, write for your copy of Engineering Handbook No. 67. Baldwin-Duckworth Division of Chain Belt Company, 355 Plainfield Street, Springfield 2, Mass.

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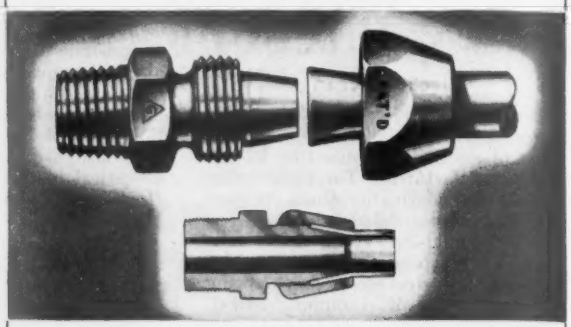
FOR AVIATION . . . .

VIBRATION TEST
1000 VPM — ½" TRAVEL
NO LEAKS*



*From Underwriters' Laboratories' Report No. 42C649 "Superseal Fittings made up with both steel and copper tubing were mounted between a rigid plate and a vibrating panel. An internal pressure of 50 psi was maintained. The samples were subjected to 1000 vpm with a double amplitude of ¼". *After 30 hours, no leakage had occurred and there was no indication of loosening of the nuts or cracking of the tubing.*"

SUPERSEAL
Flared Tube Fittings

provide leakproof joints even under maximum vibration and pressure

Check these other features

✓ **Long 10° Tapered Cone** provides greater seating area for tubing flare.

✓ **All Tubing Easily Flared to Superseal's 10° angle** . . . production flaring of welded steel tubing in one operation.

✓ **No Shearing Action** to injure the tubing at the point of flare when the nut is tightened – instead the tubing is actually strengthened.

✓ **Inside Diameter of Tubing** uniformly maintained . . . no obstructions at the joint.

✓ **Two-part Fitting** . . . no rings, no sleeves.

✓ **Tubing Bends** can be made close to the fitting.

✓ **Materials** . . . Stocked in steel. Malleable iron, brass, aluminum or alloys on special order.

✓ **Complete Line** . . . Elbows, tees, and adapters. Steel – to ½" O.D.

✓ **Parkerized and Wax Coated** . . . corrosion-resistant.

✓ **Underwriters Approved** for all hazardous gases and liquids.

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GRINNELL COMPANY

Superseal Division, Providence 1, R. I.

GRINNELL

WHENEVER *piping* IS INVOLVED

sealing and seam-sealing of gasoline bags and pressurized cabins; (4) test box reduces man power and man-hours required for checking fuselage electric circuits prior to attachment of wing panels.

Republic Aviation News, March 24, 1945. (1) Side-angle index indicator for tube-bending apparatus; (2) rotary file guide provides external bearing support for file as well as additional leverage; (3) plan for portable router with adjustable adapter to be used prior to splicing the top and bottom halves of the fuselage together performs necessary flush cut in one operation and creates a better, faster job; (4) diamond-drill holder enables all sizes of drills to be machine-sharpened and eliminates hand-grinding; (5) milling-cutter installation stand facilitates installation and removal of cutters in vertical milling machines, speeds production, and eliminates a danger hazard.

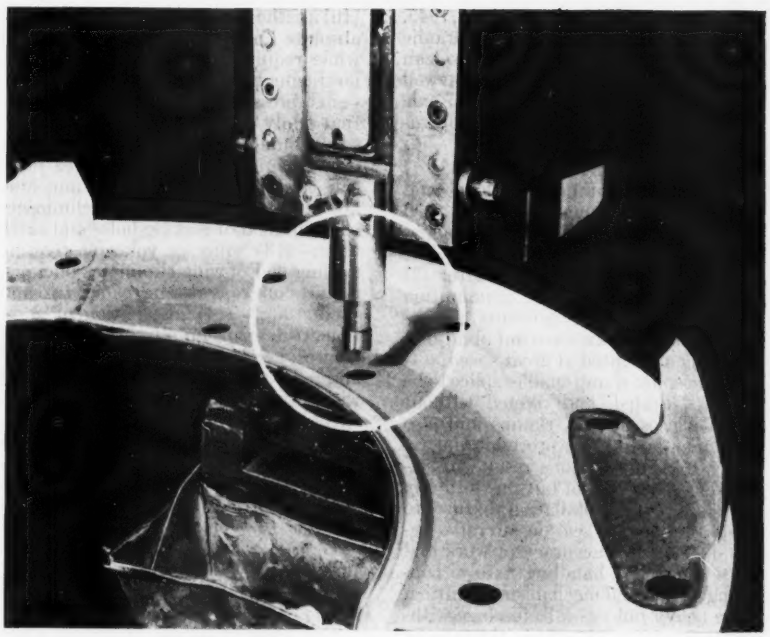
North Ameri-Kansan, March 23, 1945. Special scrapers attached to the wheels of electric cranes keep the tracks clear from all foreign matter.

The Consolidated Vultee Stinsonair, February 15, 1945. (1) Improved method of making cowling; (2) improvement on nibbler clamps; (3) device for installing harness clamps; (4) improved method of forming; (5) improved method of milling block; (6) addition of locaters to jig tubes; (7) device to hold parts in position during welding; (8) elimination of spring clamps; (9) method of reducing hand work on landing-gear beams; (10) improved method of reworking Plexiglas.

The Chance Vought News, February 22, 1945. (1) Method of plating 18 filler units simultaneously; (2) jig used for drilling the upper and lower cap strips of the main beam.

North-Ameri-Kansan, February 23, 1945. Special cutter for aluminum T-shaped stock trims T-bar to dimension with the proper edge radius in one operation, eliminating the burring operation formerly done with a hand file.

Douglas Airview, March, 1945. (1) Inserting and withdrawing alignment machine for wing-attach pins prevents binding or misalignment; (2) installation of roller guides on crane in anodic plating solves lubricant problem and eliminates considerable maintenance work; (3) movable cradle fixture to join outer wings to plane improves accuracy and enables one man to perform an operation that formerly required six; (4) use of bronze scraper and three chevron washers on milling machine corrects cause of leakage and eliminates maintenance work; (5) adaptation of Jacobs chuck for grinding counterbores and end mills eliminates grinding of shanks of individual mills and bores; (6) improved design of deicer and hydraulic lines provides for lines to be made in two pieces joined by hose and clamps, and results in easier, quicker installation; (7) improved method of handling ceiling panels through use of series of templates enables better fit in less time; (8) adapting use of 1-in. hose connections results in improved method of draining wing tanks into gasoline truck and saves 8 man-hours per plane; (9) special chuck jaws for use on inside of grinding tubes, making possible accurate cutting throughout entire length of tube, and eliminating wobble or taper; (10) use of plastalloy fingers on toggle clamps enables forming of complete fixture by dipping large bolts in plastalloy; (11) small spring and bracket assembly eliminates breakage of nipples on pneumatic stationary riveters.



Photograph Courtesy Douglas Aircraft Company, Inc.

Holes in steel engine cowlings were cut out with a hole saw or cut out with a special punch by hand power. The hole-saw method was impracticable because of the short service life of the saw. The use of the punch required considerable handwork and the complete operation took about 20 min. per hole. By using a new punch arrangement whereby the threaded shaft was connected with the metal portion of the die, holes in heavy steel are punched out by the arbor press at the rate of $1/2$ min. per hole.

Flagship World, March-April, 1945. (1) Enlarging hole in the frame of aircraft seat enables servicing of bottom seat cable without removing arm rests, thus saving man-hours; (2) standardizing scoop and muff connections eliminates the drilling of extra holes to line up replacing scoops; (3) jig for use in overhauling oil radiator air scoops and making up shutters saves labor; (4) a means of safetying turn buckles on gas and oil tank straps by use of a piece of $1/16$ in. diameter steel welding rod 10 in. long saves time and effort.

North Ameri-Kansan, March 30, 1945. Self-feeding magazine for automatic screw machine.

Edo Weekly Log, March 14, 1945. Template eliminates the need for using tape to hold rivets while riveting an assembly.

North American Aviation Take-Off, March 23, 1945. (1) Improved type of milling-machine cutter setup fixture makes possible greater accuracy in one-third the time formerly required; (2) indicator for punch press automatically shows operator whether the machine will go through only one cycle when the pedal is down or whether it will operate continuously.

The Goodyear Wingfoot Clan, March 7, 1945. Electrical wire cutter saves time and reduces scrap.

Edo Weekly Log, February 7, 1945. (1) Block for beveling small parts on the sander saves time on sanding operation; (2) adjustable gage for cutting tubing eliminates need for scribing before cutting; (3) jig for filing specimens for tensile test.

The Consolidated Vultee Eagle, March 16, 1945. (1) Device for draining fuel cell saves time and gasoline and eliminates a hazard; (2) special board facilitates gathering and winding lengths of electric wires.

The Goodyear Wingfoot Clan, February 2, 1945. Spacers for installing strip cap on Erco turret.

Eastern Aircraftsman, March, 1945. (1) Semiturntable jig for drilling and riveting the landing-gear fork assembly to a bulkhead on the wing center section saves time and material; (2) improved wiper blocks for elliptic benders save time and material; (3) pliers for holding stringers in position, also act as drill guide; (4) pliers for closing and lining up clamps and clips for the pitot and hydraulic lines of the trailing-edge assembly.

The Menasco Flying M, March 2, 1945. (1) Redesign of chip pan on hydraulic machine obviates time required to clean coolant pumps; (2) stop for Bakewell tap machine; (3) reprocessing P-47 axle to eliminate three rough-grinding operations.

Douglas Airview, February, 1945. (1) Use of holding stands for Erco and Farnham riveting machines which roll panels into position saves man-hours; (2) cutter for high-speed mill is capable of sizing and trimming armor plate; (3) support for flexible chute ammunition feed for aircraft guns prevents mechanism from being knocked out of adjustment when operated at great speed; (4) longeron splice clamp enables splice to be clamped, drilled, and riveted without use of Clecos or "C" clamps and also saves man-hours; (5) procedure for refacing Erco die buttons results in salvage of 70 per cent of buttons formerly scrapped; (6) installation fixture to locate retainer for seal on aircraft's access door assures accuracy of work and saves time; (7) handling fixture, consisting of cart and mechanism for lifting, raises heavy rail jigs into fuselage without dismantling but allows them to be combined for easier handling and a saving of time; (8) slotted holding fixture for proof-loading machine facilitates operation and saves time; (9) pressure-roller method of straightening hat section replaces hand method and reduces time required for operation by one-half; (10) method of producing drawings of absolute line quality aids metal layout while requiring less drafting time and no tracing time; (11) adaptor for use on punch press to elevate dies from bed so that oddly shaped parts can be worked saves time and releases drill press for other operations; (12) Greenlee radio chassis punch adaptor for punching holes in heavy sheet steel eliminates hand method of making holes and saves time; (13) squeezer yoke for riveting trailing end of wing eliminates bucking, requires one operator instead of two and saves time; (14) installation of additional rub strips on alternate cowl flaps assures accurate fit of cowl-flap ring and eliminates breakage of spotweld with resultant part rejection; (15) substitution of hydraulically operated adjustable passenger seats in place of mechanically operated seats results in less fabrication time, while the new seats are simpler to operate, noiseless, and weigh less.

North American Aviation Take-Off, March 16, 1945. Safety guard for Cincinnati Cylindrical Grinder.

Bell Aircraft News, March 3, 1945. (1) Right-angle screwdriver for installing Phillips screws in the carburetor air scoop reduces time required for operation; (2) edge-rounding cutter for air motor rounds edges in one pass and prevents cutter from operating on any but the desired edge.

Edo Log, January, 1945. (1) Shrinking bulkhead bounding angles instead of siamese pressing, heat-treating, ageing, and hand-hammering them save time, material, and money; (2) combination pin and center punch lines up fittings and deck rail and also center marks the bomb bay skins for the fitting hole, thus eliminating the former scribing operation and saving time; (3) jig for installing deck stiffeners reduces time needed for the operation by 50 per cent; (4) holding fixture for spot welding a door eliminates waves in material; (5) method of installing microswitches on a hydraulic-press loading table eliminates switch failures; (6) reservoir to store fluid for hydraulic lines during testing operation; (7) improved method of applying bonding blocks on strut assembly; (8) template for locating and installing clips on decking operation enables a man to perform the operation from outside the float and saves time; (9) tool for stamping out phenolic washers results in a 50 per cent time reduction; (10) holding fixture for stamping bolts after the Magnaflux operation; (11) rivet set for riveting both rivets on nut plates simultaneously; (12) automatic flanger for the flap door; (13) band-saw table guide protractor for use on bandsaws eliminates scribing operation on many parts; (14) milling cutter for use on a drill press reduces time required for trimming and shaping parts by about 75 per cent.

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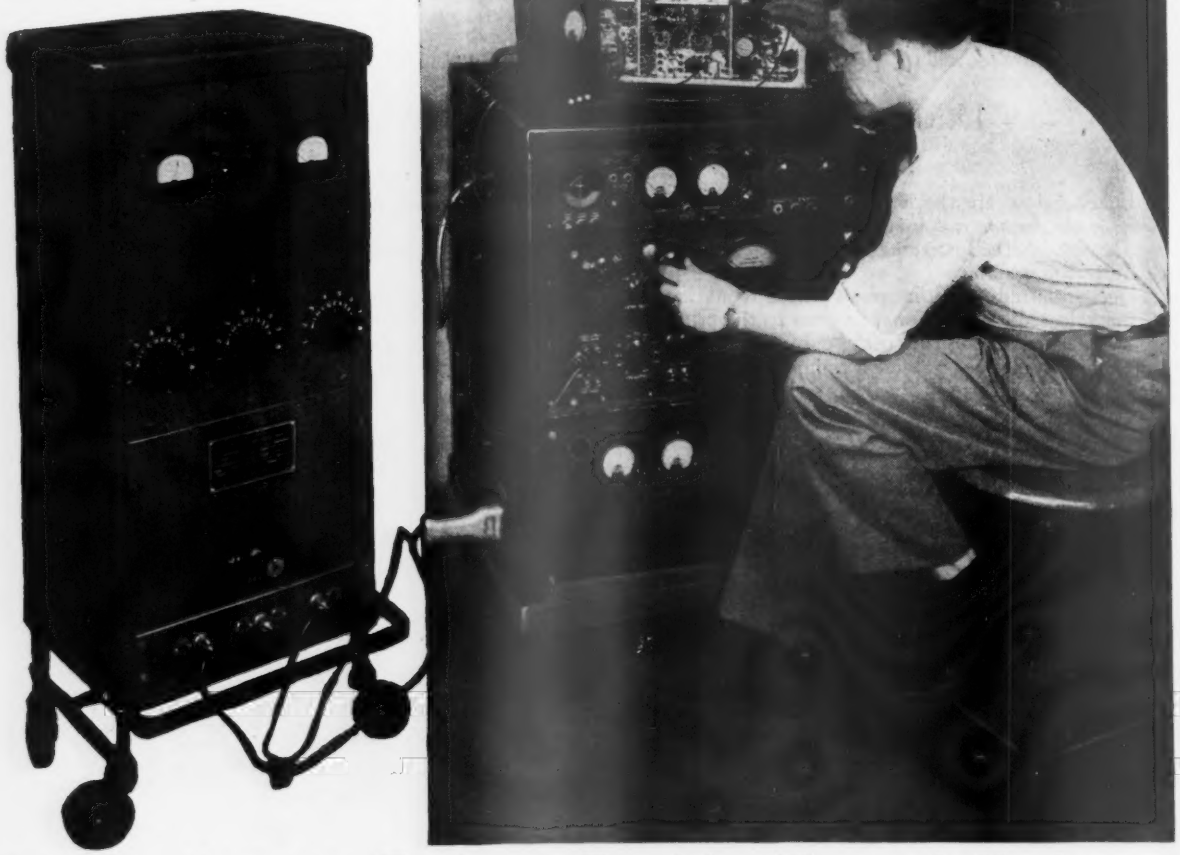
Checking an Ultra High Frequency aircraft receiver with a special testing unit at the Civil Aeronautics Administration Experimental Station. Dependable DC power is provided by this mobile Mallory Rectopower Supply, which can also be used to charge batteries.



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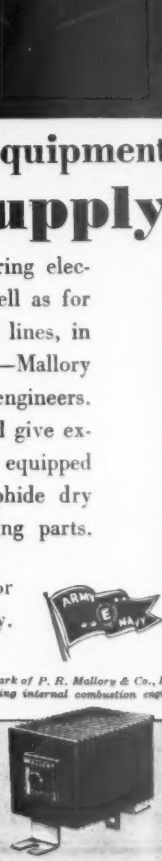

From the Industry

Air-Line Mileage Tables

A new basis for domestic air-line mileages which will make possible the use of fixed permanent figures from point to point for future air-express and air-cargo rates has been initiated by the Air Cargo Subcommittee of the Air Transport Association's Air Express Committee. The new route basis is expected to make possible an improvement in the present distribution of revenue on interline shipments of air express.

Based on Great Circle distances, originally suggested for this purpose by Air Cargo, Inc., the new plan will provide a mileage basis that, once computed, will apply at all times between points and will not be affected by the establishment of new routes, the shifting of airport locations in any city, or the adding of a new point on an already certificated route.

To ensure that the Great Circle mileages will be authoritative, arrangements have been made with the U.S. Coast and Geodetic Survey to compute the distances in statute miles between all air-line points now certificated by the C.A.A. These involved computations, which require painstaking mathematical formulas, are being calculated on special machines of the Coast and Geodetic Survey.

To ensure an equitable base for the point-to-point computations, it was necessary to ask the cooperation of the city engineer in each airport city to locate, by exact latitude and longitude, a central point from which to compute the Great Circle mileages. Many city engineers have already returned maps with such "fixes" located on them.

The resultant mileages are to be published in a booklet similar in form to those now issued by the Coast and Geodetic Survey in the United States Pilot's series and will be sold at a nominal cost to the public. The booklet will have the mileages in table form, and it will be possible to obtain the Great Circle distances between any of points now certificated as air-line stops by the C.A.A. The Great Circle mileage booklet will be of value not only in setting a base for air-line rates for express and cargo and for the division of the interline revenue in these classifications but will be a real aid in the compilation of uniform air-line statistics. It would also be of aid in the fixing of passenger rates and in the division of interline passenger revenues. It is expected that the book may be ready for distribution in the late summer. Air Transport Association.

Wartime Record of the Air Lines

Air lines of the United States have flown more than 2,500,000,000 passenger-miles on overseas war routes and have transported 600,000,000 ton-miles of war cargo in the period from America's entry into the war to the end of 1944. Containing figures released for the first time by the Army Air Forces Air Transport Command and the Naval Air Transport Service, this survey credits the contract carriers with helping to establish new routes; with meeting many crises in the early days of the war before the Army and Navy air forces were in full action with ample equipment; and with an imposing record in the transport of men, munitions, equipment, doctors, nurses, and medical supplies. More recently, the carriers under contract with the Army and Navy have participated in evacuating thousands of wounded and bringing them back across the oceans to hospitals at home. The figures show that the Army and Navy used a total of 193 air-line planes and some 1,200 air-line pilots.

While carrying on these extensive operations abroad for the A.T.C. and the N.A.T.S., the commercial air lines devoted their home-front efforts largely to war transportation, recording additional figures on domestic routes for the military forces as follows: passenger-miles flown under domestic war contracts, 114,412,093; ton-miles flown, 103,914,981; transport miles, 62,087,-339; transport hours, 400,571.

The grand totals for both foreign and domestic war transport are as follows: passenger-miles flown on war routes overseas and on war routes at home, combined, 2,696,316,089; ton-miles flown, 707,052,264; transport miles 308,919,761; transport hours, 1,828,-007.

Despite this great record of war transportation, the air lines managed to take care of an increasing amount of essential home-front civilian air travel, air mail, and air express, setting new domestic records in all categories. Air Transport Association.

Electrical Repair Kit for Solderless Wiring

An electrical repair kit for solderless wiring is supplied complete with tool and solderless A-MP terminals for standard wires sizes 22 to 10.

The special A-MP tool supplied with the repair kit has insulated handles of molded plastic and a corrosion-resistant finish. The tool allows for cutting the wire to any desired length, has a gage to determine the length of insulation to be removed, and permits the wire to be inserted in an opening with markings that correspond to the wire size for accurate stripping of insulation. The wire, stripped correctly by the tool, may then have the correct size terminal placed in position for crimping by the tool. This latter operation is accomplished by simple hand pressure. No solder is necessary.

One hundred solderless terminals of the most-used types for wire sizes 22 to 10 are supplied with this repair kit. Included are ring, tongue, line splice, butt connectors, and spade-tongue terminals. Aircraft-Marine Products, Inc., Harrisburg, Pa.

Swing Table for Metal Cleaning and Finishing

The Wheelabrator Swing Table, which utilizes the maker's airless abrasive blasting unit, extends the speed and economy of airless blast cleaning to a wide range of intricate or irregular-shaped work formerly cleaned in air-blast rooms in jobbing foundries and other metalworking plants. Four sizes of this blast cleaning machine are now available, sizes of the single work table being 24 in., 66 in., 72 in., and 86 in. in diameter. Operation of the four units is essentially the same, the machines varying only in minor construction details and number of units utilized.

Work to be cleaned is placed upon a rubber-covered work table that is mounted on the door of the blast cabinet. As the door is closed, the work table swings into the cabinet underneath a Wheelabrator airless blast unit. While in this position the table is rotated at a predetermined speed. The unit forces a continuous stream of abrasive down upon the rotating work to the full width of the table, so that all surfaces are uniformly blasted to a bright, clean finish. Only an extremely short exposure of the parts is required to clean the exposed surfaces thoroughly and uniformly. The unit is then stopped, the door is swung open, and the part is turned over for cleaning the underside.

After striking the work, the abrasive falls through perforations in the table top into a hopper below the machine. A screw conveyer transfers the abrasive to the elevator boot section from which it is carried to an overhead abrasive separator. All broken down abrasive and useless fines are removed and the usable abrasive falls into a storage hopper for reuse. One of the most im-

From Creation to Cargo

Weight's Important in Airplanes

Here are two shots of a Douglas C-54 Combat Transport getting a weight check on a Fairbanks-Morse Crane Scale and two Aircraft Scales.

THE weights of the parts that go into a plane, the amount of fuel it carries, the weight of its passengers, crew, or cargo, are very big factors in performance. Therefore accuracy is a prime essential in any scale used.

And that's why Fairbanks-Morse Scales are so widely used in the aeronautical industry. They have a long-standing reputation for lasting accuracy, featherweight responsiveness. They're precision engineered to do any job from checking weight distribution to weigh-counting small but vital parts. A Fairbanks-Morse engineer will be glad to work with you in adapting them to your problems. Write Fairbanks, Morse & Co., Fairbanks-Morse Bldg., Chicago 5, Illinois.

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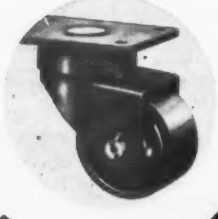

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portant features is that all blast cleaning operations are within the cabinet; the operator is never exposed to the abrasive blast or dusty conditions inherent in air-blast room cleaning. American Foundry Equipment Company, Mishawaka, Ind.

Two Technical Films on Plastics

Two technical films have been prepared as guides to the understanding of the proper uses of thermosetting plastics. They answer the practical shop questions of the foremen and the molder. They acquaint the engineer and the artist designer with the "how" and the "why" of thermosetting molding techniques. They serve as training films for engineering students and plant personnel.

Technical film No. 1 *Bakelite Plastics —Selecting the Right Thermosetting Material* opens with an account of the manufacture and molding of thermosetting materials. A series of scenes demonstrates, in general terms, how the engineer goes about selecting the proper heat-setting plastic for the application he has in mind. The next portion of the film is devoted to a study of the physical and chemical requirements of the finished part and how certain specific plastics satisfy these requirements. Mechanical strength, abrasion resistance, specific gravity, color stability, low loss factor, and other properties are demonstrated, and examples of molded parts embodying the characteristics of the base plastics are shown.

The closing scenes of the film deal with Bakelite Corporation's research organization and its accomplishments in supplying technical data upon which the engineer may base his selection of the right thermosetting molding material. Animated drawings supplement the factual reporting of the camera throughout the film. Processes that cannot be visualized even under the best conditions—such as the action inside a mold—are shown in detail by the pen of the animator. The commentary of the sound track explains the scientific details of the proper selection of plastics in terms that can be understood by the experienced engineer and the student alike.

Technical film No. 2 *Bakelite Plastics —Product Design and Molding Technique for Thermosetting Plastics* opens with a general outline of mold building and a survey of the preparation and use of plastic preforms. This is followed by a description of the various types of molds, with special emphasis on their proper use. A study is then made of three fundamental factors in all methods of molding thermosetting plastics: time, pressure, and temperature. Descriptive details of preheating methods, including heatronic molding, conclude the first section of the film. The second portion of the film is devoted to an engineering discussion of problems encountered in the successful designing of molded parts. Subjects covered include shrinkage, undercuts, ribbing, tapers, fillets, domed surfaces, holes, bosses, metal inserts, and effective styling and surface treatments.

Both motion pictures were produced for Bakelite Corporation by Caravel Films, Inc., New York. Sixteen-millimeter prints of these films are available without cost to executives, industrial organizations, engineers, designers, and educational institutions upon request. Bakelite Corporation, Unit of Union Carbide and Carbon Corporation, Technical Film Library, New York.

Portable Printer-Developer for Making Black and White Prints

The BW Model 41 printing and developing machine has a printing speed range up to 6 ft. per min. depending on the transparency of the original, printing either roll stock or cut sheets, with a printing width of 46 in. The light source is a 2,000-watt glass mercury-vapor lamp within a 6-in. diameter cylinder, designed to give uniform distribution of light over the entire printing area of the cylinder.

A new method of cooling pulls air into and through the cylinder and contact bands, resulting in minimum machine temperature. Uniform cylinder temperature within a few degrees is maintained, so as to assure uniformity of print exposure. Air is also drawn in at the front of the machine in order to provide greater comfort for the operator.

Printing speed is controlled by a single-knob dial, located within convenient reach of the operator. Suction through the bands simplifies the feeding of tracings and sensitized paper, and the tangential method of feeding provides safety for the tracings and eliminates pinching or catching. Tracings and prints are removed without scraping. A front pedal, located at floor level and at the center of machine, instantly releases the band tension so that misfeeding of roll stock can readily be corrected.

In the developing unit, speed in excess of maximum printer speed assures an uninterrupted flow of prints. Prints are delivered at the front of the machine within easy reach of the operator. A new type ironing roll results in flat, dry prints. Speed, contact, and development controls are quickly removable for cleaning, and all parts in contact with the developer are of stainless steel or are nonmetallic.

The Bruning portable printer-developer.

Mounted on four casters, the unit can be moved to, and operated in, any desired location. No plumbing connections are necessary, and there is no need for outside outlets for exhaust fumes because there are none. Charles Bruning Company, Inc., Chicago.

Insulated Aircraft Cowl Mountings

Cowl mountings of synthetic rubber, having a high rate of vibration and shock absorption and, in addition, being impervious to decomposition by oil, are being made for military aircraft. An added feature of the bushings, which are available for radial-engine aircraft cowlings, is the heightened resistance of the mountings to heat. The reason is that the method of assembly of metal inner and outer shells with synthetic rubber is accomplished without vulcanizing. The bond between metal and synthetic compound is a mechanical rather than a chemical bond. Thus, heat does not affect the mounting until temperatures beyond safe operation have been passed.

Use of a mechanical bond rather than a chemical bond permits the use of virtually any combination of natural or synthetic rubber with such widely diversified materials as plastics, wood, steel, brass, and others. Moreover, the elements of the assembly do not have to be symmetric, since the method of manufacturing insulated bushings and mountings can be employed with equally good results with component parts of virtually any size and shape. Bushings, Inc., Berkley, Mich.

Lightweight Rivet Gun

The G-35 lightweight rivet gun is designed for installing Cherry blind rivets in inaccessible places. It is operated with one hand, installs the rivet from one side of the job with a pulling force, and eliminates the necessity for the services of a man on the other side of the work piece. It is used for installing rivets in sheet metal, plywood, rubber, plastics, and almost any soft or brittle material.

The gun measures only $11^1/_2$ in. in length and weighs approximately $1^1/_2$ lbs. The pulling head is notched so that it snaps onto or off the gun quickly and easily. Pulling heads are interchangeable for any standard Cherry blind rivet of aluminum, copper, or steel. Cherry Rivet Company, Los Angeles.

Paint and Lacquer Adhesion to Aluminum

Methods have been evolved by which aluminum and its alloys can be easily, quickly, and economically prepared for painting and lacquering to obtain excellent adhesion and corrosion-resist-

ance qualities. The surface preparation can be done either in the shop as a hot-immersion process or in the field by cold spray, brush, or immersion.

The hot-immersion method consists of dipping the work for from 3 to 30 min. in a hot chemical solution, rinsing, and drying, after which it is ready for painting or lacquering. The cold spray, brush, or immersion method consists of applying a chemical solution at room temperature by spray, brush, or immersion, allowing from 15 sec. to 1 min. for setting, and then rinsing the surfaces free of the applied solution. The work is then dried and is ready for painting or lacquering.

Both methods are reported to be excellent for paint and lacquer adhesion and may, in many cases, replace the sand blasting or anodizing of aluminum surfaces. The hot-immersion method is stated to be better for increasing the corrosion resistance of the aluminum. The cold method is of special interest since it can be applied in the field or to aluminum assembled in place. Colonial Alloys Company, Technical Processes Division, Philadelphia.

Solid-Bit Cutting Tool

A new solid cast steel cutting tool is produced by melting a special cobalt-steel alloy in an indirect-arc rocking electric furnace, superheating to well above 3,000°F. and casting it in molds of the approximate tool size. This process is said to give the metal a preferred grain and carbide-particle size at the time of casting, thus doing away with the need of forging and later heat-treating.

It is stated that the process results in a tool that will retain its cutting ability on many types of work several times longer than has heretofore been considered possible and that cutting speeds can safely be increased by 20 per cent. However, the tool bits are not recommended by the maker as a cure-all for every kind of cutting job. The specific types of work to which they are suited have been determined after a series of tests made in cooperation with several large manufacturers.

"Powersteel" solid tool bits are supplied hardened and ground, ready for use. They can be resharpened and used as long as the tool can be held in the holder. They require no change in present equipment or shop practice. They are available from stock in nine standard sizes of square bits and five sizes of rectangular bits. Crobalt, Inc., Ann Arbor, Mich.

Electronic Deicer Timer

The Eclipse electronic timer is designed for use in conjunction with the manifold-solenoid deicer system and provides automatic or manual remote electrical control of deicer-boot operation, opening the boot-inflating valves automatically in the proper sequence and for the effective time intervals. Control of the deicer system for light icing, light to moderate icing, severe icing, and high-altitude conditions is provided. The timer is intended to control the system for both rate of accretion and texture of ice formation.

Although primarily designed for new aircraft, any manifold-solenoid deicer system now using the Eclipse mechanical timer can be inexpensively and quickly converted to the Electronic De-Icer Timer by merely changing the AN connector on the existing cable. Laboratory tests under room-temperature, cold, sea-level, and altitude conditions are reported to have shown that the electronic timer will function, without adjustment, for more than 1,000 hours of icing time.

The timer can be wall or flush-panel mounted. It is so designed that it may be opened for inspection from the front while in operation. The unit measures $8^7/_8$ in. long, $6^5/_{16}$ in. high, $3^3/_4$ in. deep and weighs 6.5 lbs. Eclipse-Pioneer Division, Bendix Aviation Corporation.

Wing-Flap Drive Unit

Designed specifically for wing-flap actuation on the Douglas A-26, a self-contained motor unit had to meet stringent weight specifications. The 2-hp., 7,500-r.p.m. motor is of the intermittent-duty type. It is equipped with magnetic clutch and brake and, in addition to being thermally protected, is protected against exposure to dust, sand, and salt spray. The unit is designed for low impact torque to prevent damage in the event of overtravel resulting from failure of electrical stops. Electrical Engineering and Manufacturing Corporation, Los Angeles.

Electrical Engineering & Manufacturing Corporation's wing-flap actuation motor unit.

High-Voltage Rectifier

The new EE Type 3B 27 rectifier tube is offered to fill the need for a high-voltage rectifier tube of rugged construction suitable for industrial and mobile-transmitter use. The tube is a high-vacuum type designed for application where disturbance from the power supply must be kept to a minimum.

Construction features include double heaters and cathodes, ceramic spaces for low leakage, and extra heavy supports for resistance to severe vibration and mechanical shock. Ratings are: peak inverse voltage, 8,500; peak plate current, 0.6 amp.; average plate current, 0.150 amp. Four tubes in full bridge deliver 5,415 d.c. volts to the filter, with 6,000 volts total input. The filament draws 5.0 amp. at 2.5 volts. The base is a medium four-pin bayonet. Electronic Enterprises, Inc., Newark, N.J.

Fighter Camera Application

A problem in rapid reconnaissance photography was to install standard small automatic aerial still-picture cameras in fighter airplanes engaged in air and ground coördination operations and let them photograph their own strikes. The camera had to be mounted so as not to interfere with the plane's flight behavior or its ability to bomb and strafe. It could not add any additional duties for the pilot, nor could it reveal to the enemy by special markings, windows, and the like, that the fighter was so equipped.

After several experimental installations, photographic officers and technicians on the Italian front mounted a Fairchild K-25, 24-volt camera in a special bracket fixed to the jack pad and the bomb-shackle-sway brace. This bracket was shock-padded with sponge rubber, and its top half had an arm extending forward to hold an adjustable clevis that enabled the camera to be raised or lowered for bore sighting. Every precaution was taken to hold the camera rigid and to eliminate all movement and vibration. A special fairing was constructed, held in place by three fasteners. The K-25 camera is an automatic version of the K-20 camera. It is operated by a push-button control from the cockpit and exposes 50 4-by 5-in. negatives in 20.8 sec. Fairchild Camera and Instrument Corporation.

Packet Gets More Powerful Engines

New Double Wasp engines of increased military and normal power ratings at altitude are being installed in production models of the Fairchild C-82 Packet, replacing those in the prototype. Rated at 2,100 take-off hp., they are purported to be the most powerful Pratt & Whitney Aircraft engines in use on a production airplane. They incorporate provision for water-injection equipment to give extra emergency power.

Improved supercharging gives the single-stage, two-speed R-2800C engines 100 additional hp. at altitude and allows the C-82 full-power take-offs from airports several thousand feet above sea level as compared with an elevation of 1,000 ft. for such take-offs with the earlier engines. Fairchild Engine & Airplane Corporation.

Remote Reading Flowmeter for Aircraft

A remote-reading flow-rate meter has a new, patented electrical circuit in which the transmission to the remote indicator is completely electrical. It is based upon the Rotameter as the prime flow-rate measuring element, so the calibration is a straight line and the electrical transmission reproduces this feature in the remote indicator, thus giving evenly spaced scale divisions. The accuracy of the Rotameter is retained in the remote indication, even at the lowest part of the flow range.

The Rotameter used for the prime flow-rate measurement is the patented "Stabl-Vis" type, which automati-

cally compensates for variations in viscosity and density in the fluid being metered. The reproducibility of the initial calibration is obtained regardless of flying conditions and in spite of normal differences in the composition of the fluid for which it is calibrated. The weight of the instrument is only $6^1/_4$ lbs. total for the meter and remote indicator. Fisher & Porter Company, Hatboro, Pa.

Transformers for Operation of Aircraft-Instrument Lights

With an output capacity of 30 volt-amp., either of two new 115-volt, 400-cycle, single-phase transformers, designed to operate 6-volt aircraft-instrument light units, permits simultaneous operation of 25 lamps at full brilliancy.

One of the transformers is provided with taps that facilitate the preselection of any desired light level within the unit's range of 6 to 1.74 volts. The taps are so arranged that each successive voltage reduction approximately halves the previous candle-power output of the lamps. Taps are not provided on the other unit, but any desired light level can be maintained by using a potentiometer to vary the transformer voltage.

The tapped transformer weighs 1 lb. and the other 0.8 lb. The mounting clamps are protected against corrosion and the terminal boards are constructed of vibration- and shock-resistant material. General Electric Company.

Electric Heating Blanket for Wounded Airmen

An electrically heated casualty blanket for the Army Air Forces consists of an electrically heated layer, well insulated with a wool fabric. It is lined with Nylon to which a thin coat of Neoprene has been applied. It will protect a man to temperatures as low as $-60°F$.

To ensure that the casualty is given the proper amount of heat, an automatic control is provided with each blanket. This control is built on the same principle as the automatic control unit used with the domestic heating blanket. It automatically compensates for changes in temperature, wind, altitude, and voltage. General Electric Company.

Built-In Type Oil Filter

The Hilco Flite-Filter is designed for attachment to aircraft engines for filtering lubricating oil while planes are in flight. The filters are connected into the pressure system of the aircraft-engine lubricating line where a small portion of the lubricating oil is taken off for bypass filtering. A second method is to install a small rotary pump which takes oil from the sump or hopper tank, forcing it through the filter and back into the tank. The unit contains a filter element made up of Hiltex, a specially processed cellulose suitable for filtering straight-run mineral or heavy-duty detergent-type oils. The filtering material removes carbon, dust, abrasives, and acids, helping to keep the oil and internal mechanism of the engines clean. The unit measures 6 by 17 in. and the total weight, including oil contained in the housing, is 15 lbs. The Hilliard Corporation, Elmira, N.Y.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Hydraulic Machine Straightens and Stretch-Forms

The Hufford stretch-leveling table, especially developed for permanently straightening and leveling long narrow metal sections that are twisted, bent, or otherwise distorted after rolling or heat-treatment, is designed for straightening rolled and extruded metal used for aircraft-fuselage stringers and similar structural parts.

The machine consists essentially of two hydraulically operated tension cylinders mounted in steel brackets, which in turn are attached to a long, massive steel bed. The tension cylinder at the control end of the table is stationary, while the opposing cylinder is adjustable along the length of the table in 5-in. increments to accommodate various workpiece lengths. Both cylinders tilt upward to a maximum of 30° for stretch-forming work and are actuated and positioned by means of small auxiliary cylinder assemblies. The piston rods are equipped with air-operated gripper jaws that hold the work securely yet will not freeze. Hydraulic pressure for operating all cylinders is provided by an electric motor driving a vane-type hydraulic pump that obtains its fluid supply from a reservoir located inside the table frame. Opening and closing of the pneumatic gripper jaws located on the end of both tension-cylinder piston rods is accomplished by operating a selector valve on each jaw.

The machine handles sections up to 40 ft. in length of any shape and many materials. It not only straightens the stock by establishing a "set" in the metal through a slight predetermined stretching of the material but also can be used in conjunction with a die for stretch-forming the workpiece to contours up to 30°. It has a pull capacity of 40 tons with a 19-in. stroke on each hydraulic piston, but it can be built in higher or lower capacities to meet the varying requirements of straightening work.

Control over straightening and stretch-forming operations is maintained at a central control panel containing valve levers for actuating the tension-cylinder piston rods and a variable sensitive hydraulic control that permits manual regulation of the tension applied to the work. The adjustable tension cylinder can also be operated by remote controls located on the assembly. Hufford Machine Works, Inc., Los Angeles.

Etched Glass Radii Charts

Etched glass radii charts are available for use with optical comparator and contour-measuring projectors. They can be furnished in either "Mirror Image" clear glass or "Right Image" optical ground glass.

Chart "A" is designed for use with 20× lens. This chart will measure radii from 0.005 to 0.312 in., inclusive, in increments of 0.001 in. Chart "B" is designed for use with 25× lens. It will measure radii from 0.005 to 0.250 in., inclusive, in increments of 0.001 in.

Chart "C" is designed for use with 31.25× lens and will measure radii from 0.005 to 0.204 in., inclusive, in increments of 0.001 in. When the charts are used with lenses of double the magnification specified, the figures are divided by two, and chart "B" is suitable also for use with a 100× lens, in which event the figures are divided by four. Hy-A-Log Company, Chicago.

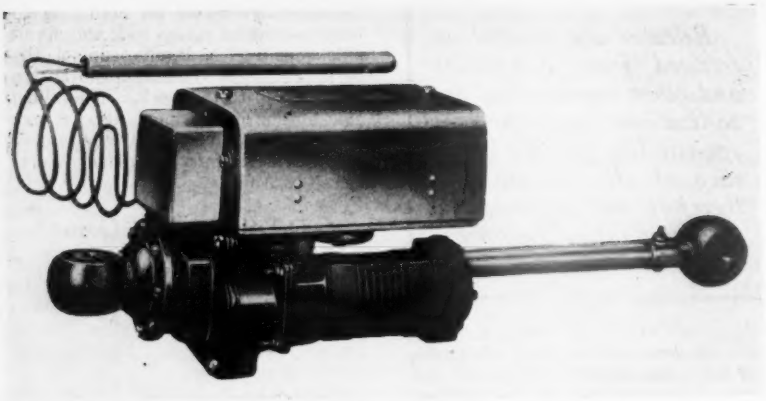
Lear Linear Actuators

The new Model "400" Series of linear actuators, weighing as little as 3.05 lbs., have been built to meet a demand for an efficient method of converting electrical energy into linear actuating force with the least possible weight and size, yet giving the required power. These actuators are designed to operate under loads up to 400 lbs. of compression or tension. They require low power, 24–28 volts, and have low current drain on the electrical system. In size, the "400" model is less than 5 in. wide, and less than 7 in. long, including the limit-switch control box and the thermal protector. The extension length ranges from $14^7/_8$ to almost 25 in. Exact positioning under all conditions is claimed by the maker.

Control boxes are equipped with limit-switch control of two or three or more positions. Incorporation of the "Fastop" clutch eliminates any overtravel. A movement of a few thousandths of an inch disengages the driven disc of the clutch from the driving disc, which is secured to the armature shaft. Gear reduction ratios are available in various combinations. Position-indicating transmitters for visual check are also available.

The motor runs at average speeds of 9,000 to 11,000 r.p.m. and is designed only for intermittent duty. Special designs can be furnished for continuous duty. Controls that respond automatically to changes in temperature are available. Immersion elements for use with air, oil, or glycol, as well as manual controls, can be supplied.

Aircraft applications for the 400 series of linear actuators include air-



The *Lear* Model 400E electrical linear actuator with temperature control.

filter doors, intercooler shutters, carburetor air duct shutters, trim tabs, dive flaps, oil cooler shutters, and glycol cooler shutters. Lear, Inc., Piqua, Ohio.

Tube-Flaring Machine

The Model DF Leonard Tube Master was developed at the request of major aircraft manufacturers to produce a double thickness of metal on the flange of flares, thereby tending to enable the tube to hold a much greater working pressure and prevent failure at the tube connection. While the machine is intended for nonferrous tubing in sizes of $^1/_8$ to $^1/_2$ in., special dies can be furnished to handle annealed ferrous tubing in sizes of $^1/_8$ to $^3/_8$ in. It is entirely pneumatic in operation and requires an average of 100 lbs. of air pressure.

To produce double flares, the operating lever, which indexes at three positions, is pressed to open the dies for insertion of tubing. Then, by moving the lever to the other two positions, the flare is completed. Double flares can be produced at the rate of 400 to 600 flares per hour, depending upon the aptitude of the operator. The overall size of the machine is height, 42 in.; width, 20 in.; length, 28 in. Weight packed for shipment is 450 lbs. Leonard Precision Products Company, Garden Grove, Calif.

Sighting Panel for Navy Corsairs

A bullet-resistant glass panel of high-precision quality is used directly as a gun-sight reflector on Navy Corsair fighters. The panel is installed in front of the pilot. It gives armor protection along with greatly increased visibility and sighting accuracy.

The "night-fighter panel" is made of laminated plate glass, $1^1/_2$ in. thick, and weighs approximately 50 lbs. Development of the panel made it possible to eliminate a reflector plate usually used for sighting. A special method is used to select glass that is free of optical defects and might interfere with proper functional use of the gun sight. Precision grinding and polishing, followed by resurfacing of the glass after lamination, produce the required optical qualities. Libby-Owens-Ford Glass Company.

Hermetically Sealed Electric Meters

In applying the principles of vacuum-tube sealing, in addition to other design refinements, engineers are stated to have achieved true hermetic sealing in a group of newly perfected, hermetically sealed $2^1/_2$-in. and $3^1/_2$-in. electrical indicating instruments.

By building the mechanism into a protective cuplike frame and then sealing the glass cover to the metal rim, hermetic sealing has been effected with a minimum number of seals. There are no rubber gaskets or cement seals.

Tests are reported to have proved that the instruments can be immersed in boiling brine solution for weeks, or frozen to −40°F., without deterioration of the seals. The window-sealing process was developed and perfected in cooperation with the engineers of the Corning Glass Company.

Windows are of double-thickness tempered glass, are processed for solder sealing, and are highly resistant to shock. Completely dehydrated, the instruments are filled with dry air at sea-level pressure. A newly designed crowned crystal permits greater scale length, reduces shadows, and makes for better visibility. Magnetic shielding makes possible interchangeability on any type of panel without affecting calibration. For extra radio-frequency shielding, the instruments can be supplied silver plated.

Silver-clad beryllium copper hairsprings reduce zero shift at all temperatures. The standard Kovar glass-bead type terminals with solder lugs and the special phosphate finish on the case (which meets a 200-hour salt spray test) are among the features incorporated in the new instruments. The meters are available in all d.c. ranges. Type HM 2 is directly interchangeable with A.W.S. type MR 24 and 25. Type HM 3 is directly interchangeable with A.W.S. type MR 34 and 35. Marion Electrical Instrument Company, Manchester, N.H.

Flush-Surface Rivet

Manufacturers who are experiencing rivet difficulties will find a solution to many buckling, sealing, and projecting-head riveting problems in a flush-surface rivet. The new rivet is designed with a soft malleable head that flares out in the shape of a truncated cone from the stem, with a thickened edge portion extending above its top surface. This edge, when the rivet is driven, is extruded as a flush extension of the head.

Of particular value for fastening thin, lightweight metal sheets, the rivets can be manufactured in various sizes and dimensions to fit the particular types of sheets to be riveted together. Though they can be made of any malleable metal, most of the experimental work was completed with aluminum alloys of the type currently used in aircraft construction.

In making experiments, it was found that in former types of riveting, where holes are driven in the metal sheets and projecting-head types of rivets are used, the sheets are deformed and the head is driven into the depression formed in the surface of the sheet beneath the rivet head. An uneven surface across the joint results and liquids often seep through beneath the rivet head. The same is true when riveting is closely spaced, because of the buckling of the metal sheets between the rivets.

The outstanding feature of the new development lies in the thickened edge of the head which provides the necessary additional metal to fill the depression in the top of the metal sheet, thus making a tight joint for the rivet head and the overlapped sheets and giving greater strength for the holding surface of the head. The added holding strength, made possible by the resulting increased surface area, is especially valuable in riveting thin metal sheets where failure frequently occurs by one sheet tearing away from the rivet. An additional advantage is obtained from the flush-surface head design because the projecting head of the older type rivets is eliminated. The Glenn L. Martin Company.

Trunnion Fixtures

The use of trunnion fixtures in the building of many assemblies of planes has reduced man and manufacturing hours and improved working conditions by decreasing fatigue. This type of fixture, which permits the assembly to be turned over while remaining in the fixture, also increases the safety factor.

Each of the trunnion fixtures in use has been designed for the particular assembly that is to be built in it. For example, at one time the center crown of the B-26 Marauder was placed in a convex riveting rack to be riveted from the upper side. It was then moved to a concave riveting rack, in which it could be placed bottom side up, and riveting done on the under side. When this was completed, the assembly was moved back to the first rack.

The procedure involved two moving operations. The two riveting racks also occupied a large amount of floor space. Now the center crown is placed in the trunnion fixture, which permits the assembly to be turned over and which can be locked in four different positions. It eliminates one fixture, as well as the necessity of moving the assembly from one to the other. The trunnion fixture also facilitates the addition of subassemblies to the center crown, making inspection much easier and quicker. Some of the new fixtures can be locked in a great number of positions, such as the aft tail stabilizer of the B-26 which can be locked at twelve different angles.

These fixtures are being used extensively on the B-29 nacelles not only for small subassemblies but also for the larger assemblies, where they save both time and man power and improve the quality of the work by making the different parts more accessible and convenient for the worker. The Glenn L. Martin Company.

Piston-Type Air Pressure Clamps

A production gain of 15 per cent, with no additional personnel and a marked reduction in arm and hand fatigue of the operators on stretch presses, is claimed to have been made through the development of piston-type air-pressure clamps. The new device eliminates the necessity for C or other type clamps on most operations.

In addition, the new clamps are said to have improved practically all other phases of the work. The more than 900 lbs. of pressure they make possible have proved ample for holding all parts securely in the presses. Man-power shortages have been alleviated, for women can now perform many of the jobs formerly done only by men. Now the operators have only to set the clamps within operating tolerances when the first part is run through. No other adjustment is necessary. The parts are fitted into the machine, the pressure clamps controlled by a set of levers, and the stretching operation is completed in the normal manner.

At the present time the clamps are being used only on presses where parts to be stretched have a constant contour. However, experiments are under way to make them adaptable for other types of clamping jobs. The Glenn L. Martin Company.

Comparator Apparatus

Model C1000 Faxfilm comparator apparatus for making surface inspections is compact and portable. One side of a piece of clear plastic film is softened by use of a small amount of solvent so that when it is pressed onto any surface it penetrates every unevenness of the surface. After a specimen frame has been made it is inserted in the right-hand frame holder. A standard-finish frame is inserted in the left frame holder. By means of two rheostats the intensity of the light is equalized for the two projectors. The frame holders are inserted in the two projectors, and the images are thrown onto a screen through reflectors.

The frame holders can be shifted to bring any portion of the Faxfilm into any position on the screen to permit surface inspection and comparison. The standard enlargement with the Model C1000 is 100 diameters. The microprojectors are equipped with 1-in. focal lenses, which require a focal length of 100 in. This length is provided by the distance from the lenses to the reflectors and back to the screen. Rex D. McGill, Cleveland.

The development of piston-type air-pressure clamps has resulted in a production gain of 15 per cent with no additional personnel and a marked reduction in arm and hand fatigue of the operators of stretch presses at The Glenn L. Martin Company.

Film Shows Operation of the AT-21 Gunner

The AT-21 Gunner is the title of a motion-picture film that shows how this twin-engined airplane enables pilots to make the transition from single-engined planes to the heavier bomber types. Flight scenes portray the rate of climb, the stalling characteristics and the maneuverability of the AT-21 airplane. Produced for the Fairchild Engine & Airplane Corporation, the picture is a companion film to Fairchild's *PT-19 Trainer*, which has been widely shown by schools, colleges, industrial plants, aviation groups, engineering societies, service clubs, etc., throughout the country.

Scenes filmed at the Fairchild Duramold Division show how lightweight construction enables the AT-21 to attain unusually high speeds. Other scenes, made at the Al-Fin Corporation, demonstrate how pure aluminum fins are bonded to steel cylinder walls. The sound track carries narration in nontechnical language explaining the 25-min. film. The Princeton Film Center, Princeton, N.J.

New Technique to Measure Engine-Propeller Efficiencies

A new technique for measuring the efficiency of engine-propeller combinations is being used in flight tests. It involves the use of a Bolex movie camera coupled to an intervalometer set to take four frames per sec. and an accurately constructed screen grid to provide a graphlike series of pictures. From these the performance of the various propellers and the engine can be calibrated.

The camera is mounted rigidly 5 ft. behind the screen. The grid is formed by fine wires spaced with great accuracy just 1.2 in. apart, both horizontally and vertically. It is 30 in. high and 120 in. long. When placed 1,000 ft. from a runway, each square measures 20 ft. of runway.

Knowing that $^1/_4$ sec. elapses between each exposure and that each square on the grid covers 20 ft. of runway, the

Measuring the efficiency of engine-propeller combinations by the use of motion pictures taken through a screen grid at the Flight Test Department of Ranger Aircraft Engines Division, Fairchild Engine & Airplane Company.

engineer can readily determine many things about a flight from the motion picture of it.

In a take-off test, the length of the airplane's ground run can be measured, the acceleration rate determined, and its rate of climb ascertained. The angle of climb is shown by a black stripe painted along the centerline of the plane.

Used to gather landing data, the equipment shows the landing speed, rate of descent, angle of descent, and ground roll. By measuring the glide path with engine throttled, it is also possible to determine the lift/drag ratio of the airplane. The same technique can be used for measuring speed runs.

In practice, the film shot during a test is projected and a graph is drawn from it. By comparing such graphs, the efficiencies of the various propellers can readily be compared. Ranger Aircraft Engines Division, Fairchild Engine & Airplane Corporation.

High-Speed Hydraulic Rams

Using 4,200 lbs. per sq.in. as the basic pressure, a group of lightweight steel rams is available for assisting motivation or supplying force in many applications. Sizes available vary from $^1/_2$ to 6 in. in diameter. They supply forces of 500 lbs. to 40 tons if used with standard foot-power units or motor-driven pumps and valves manufactured by the company.

Most of these rams can be furnished with spring return. When used with 1-cu.in.-per-stroke foot-power units, movements from 0.1 to 4 in. result. Reimuller Brothers Company, Franklin Park, Ill.

"On and Off" Flasher Operates Blinking Lights for Landing Fields

The new Reco Thermo Flasher No. 4188, operating a magnetic relay and lamps, makes it possible to mark the boundaries of an emergency airplane landing field at night with lamps flashing "On and Off." It is designed so that the lamps will remain lighted despite failure of the flasher.

The unit is supplied in a cylindric metal container $1^1/_2$ in. in diameter by $1^1/_4$ in. long. The complete flasher weighs approximately 2 oz. It is made with a standard four-prong base for quick and easy replacement in a radio-type socket. Under normal conditions the unit will start flashing at 110 volts in from 3 to 5 sec. Reynolds Electric Company, Chicago.

Dimpling Process for New High-Strength Aluminum Alloys

A successful method for dimpling high-strength, heat-treated aluminum alloys in all thicknesses up to and including 0.081 in. utilizes a tool that fits the standard dimpling machine. The procedure is reported to be simple, inexpensive, rapid, and easily taught to the operator. It produces strong, well-formed dimples in high-strength aluminum alloys without radial or circumferential fractures. The success of the process is attributed to the fact that the metal is formed in such a manner that the stresses are distributed over a wider area, eliminating stress concentrations and their consequent fractures. Information about this process, for which patent applications have been made, will be sent to any interested concern. Ryan Aeronautical Company, San Diego, Calif.

Internal-Measuring Instrument

The Model N-5 internal measuring instrument embodies both mechanical and electrical principles and is sometimes referred to as the "hole checker." This comparator-type instrument is equipped with an electric gaging head known as the Electrigage, an improved amplifying device with a ratio of 2,500 to 1 developed jointly by the maker of the instrument and the Westinghouse Electric & Manufacturing Company. Other amplifications may be had on special order.

A new type of electrical magnification causes instantaneous action of the indicator hand. There is no lag, and the stylus has a feather touch so that gaging pressure need never exceed 3 oz. A fine-adjustment knob is used in obtaining a zero setting. An automatic stabilizer prevents ordinary voltage variations from affecting the accuracy of the readings.

The N-5 is normally used at the bench

The Sheffield internal measuring instrument, developed jointly with the Westinghouse Electric & Manufacturing Company, has a gaging head that includes minimum and maximum gaging diameters of 0.370 and 12 in. Special gaging arms can be supplied for checking holes down to and including 0.240 in. in diameter.

in receiving-department inspection or in the toolroom or gage laboratory for checking master and working ring gages, setting snap and length gages, checking tools, and other high-precision work having one or more internal dimensions. Precision blocks or masters are used as a reference in setting up the instrument. A limit-switch arrangement operating two red signal lights assists the operator in making the setup and in properly positioning the work for checking.

The gaging range includes minimum and maximum gaging diameters of 0.370 and 12 in., respectively. The surface plate is adjustable vertically. It is possible to explore a hole 3 in. deep for diameter, taper, bell mouth, and out-of-round conditions. The instrument can also be supplied with special gaging arms for checking holes down to and including 0.240 in. in diameter. The maximum gaging depth from the surface plate to the center of the diamond points on these arms is 1 in. The linear scale is of the balanced type having a total range of 0.0012 in. All critical and exposed parts are chrome plated for longer life. Tungsten carbide is used at points of contact to minimize wear. The Sheffield Corporation, Dayton, Ohio.

Laboratory to Study Jet-Propulsion Fuels

A laboratory for the study of fuels and lubricants for jet-propulsion aircraft has been built and put into operation at Wood River, Ill. The laboratory, a complete, full-scale installation, was designed to study the action that fuels undergo in jet combustion. A jet burner, whose size and construction remain a military secret, has been installed; fuel is furnished by ten 5,000-gal. tanks; and compressed air, necessary for jet combustion, is supplied by a 1,000-hp. compressor.

Combustion of such a character requires new basic research, and new studies of burning characteristics of possible fuels have been undertaken. By means of elaborate electrical recording devices located in a heavily soundproofed control room, the new laboratory is compiling performance records on fuels suitable for use in jet-propulsion and combustion-turbine engines. In addition to surveying fuel requirements and determining characteristics and qualities of fuels most efficient for jet combustion, the laboratory is also at work developing new experimental apparatus for further use in this type of research. Shell Oil Company, Inc.

Film Shows Instrument Operation

The Attitude Gyro is a sound motion picture demonstrating this Sperry aeronautical instrument in action, installed in a P-47 fighter. The 16-mm. film is black and white, with sound track, on a single reel of 15-min. running time. It is available through advance booking for all interested groups. Sperry Gyroscope Company, Inc., Central Film Service, Great Neck, L.I., N.Y.

Open-End Bar Shears

Open-end vertical bar shears, designed in ten sizes and with ram pressures of from 25 to 300 tons, offer shearing capacities for rounds ranging from 1 to 3 in.

The open-end feature is stated to represent a major improvement over conventional closed-end shears, enabling quicker and more accurate handling and making the shear blades easy to see and change. The new shears also have the advantage of being adaptable for punching and plate and angle shearing. The ram is machined for attaching various types of punching-tool arrangements, including single, double, or triple gaged units; cluster punches; or floating punches.

Frames of the new machines are constructed of rolled steel plate, with a heavy steel throat section welded into place. The multiple-jaw type clutch has a positive automatic kickout for stopping the ram at the top of the stroke. The flywheel is mounted in roller bearings located within the frame for safety and to eliminate an overhung load on the bearings. A V-belt motor drive provides quiet operation and reduces shock load on the motor.

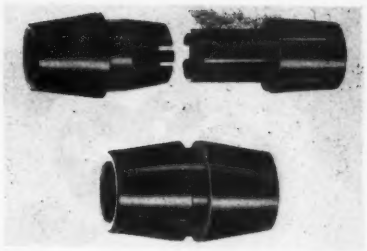
Pressures, capacities, and general specifications of the machines are given in Bulletin 317. Thomas Machine Manufacturing Company, Pittsburgh.

Spring-Steel Latch

The spring-steel Speed Nut Latch No. 1663 has been developed for instant attachment and removal of box covers, access doors, panels, and inspection plates. The spring arms of the latch snap over ball or grooved studs to provide firm attachment, yet the studs may be quickly withdrawn. The latch is available in five material thicknesses to provide the desired degree of pull-out tension. Three styles of ball studs are available, drilled and tapped for 6-32 screws, threaded shank (6-32 thread), and plain shank for riveting. These, as well as the grooved stud, are provided in various lengths to suit application requirements. Tinnerman Products, Inc., Cleveland.

Plastic Blind Grommet

The noninflammable plastic blind Des-Grommet is offered for insulation and protection of cables and lines passing through bulkheads of ships and aircraft and for hundreds of applications of electrical insulation. It is composed of two parts, molded from a special noninflammable formula of Lumarith and prepared especially for the maker by the Celanese Corporation. The two parts are so designed that they may be applied from one side only by means of a special tool. To install the grommet, it is slipped onto a special tool and thrust through a hole in the partition. As the grommet is drawn together, an undercut section on one half is engaged with a spring locking section on the other. The tool then forces the two sections together, locking them into one integral unit at the point at which the partition stops further movement.



The Victory Manufacturing Company's noninflammable plastic blind Des-Grommet for insulation and protection of cables and lines. These grommets are available in transparent plastics and in a wide range of colors.

The grommets are furnished in a wide range of sizes to accommodate cables and tubes from $^1/_4$ through 2 in. in diameter. Two sizes are supplied for different wall-thickness measurements: one for $^1/_8$ to $^1/_2$-in. in thickness and the other for bulkheads $^1/_2$ to 1 in. thick.

By the addition of an exterior pressure ring, which is installed over the cable and locked into the grommet, the installation may be made pressure- and watertight up to 25 lbs. per sq.in. An unlimited range of colors is available in suitable plastic materials. Colors may be used for identification purposes, while the clear grommets facilitate inspection. Victory Manufacturing Company, South Pasadena, Calif.

(*Continued from page 104*)

Planes to Burn. Frank J. Taylor. This article deals with the problems of disposing of surplus U.S. warplanes. Explaining why there are surplus aircraft and differentiating between the various causes for such surplus, the article also tells of the methods by which the planes are disposed of and utilized. It relates the functions of the Aviation Division of the Surplus War Property Administration and details the processing of a surplus airplane by this division. *The Saturday Evening Post*, March 17, 1945, pages 20, 105, 106, 2 illus.

Flight Pay in the Services. The pay received by flying personnel of the U.S. Navy, Coast Guard, Army, and Marine Corps is listed in tabular form. The table and supplementary explanations show base pay, base-plus-flying pay, base-plus-flying pay plus foreign service, rental, subsistence, allotments, and longevity pay. *Flying*, April, 1945, pages 50, 156.

1945 Catalogue and Directory. Firms supplying equipment and services relating to aircraft and airport construction and maintenance are listed. The listings appear under headings classifying 660 different items used in the aeronautical industries. The list includes United States and Canadian firms. *Commercial Aviation*, February, 1945, pages 42–92.

"ORCO" Rubber Parts used in Jack & Heintz Automatic Pilot

THE PART THAT PARTS PLAY IN PRODUCT PERFORMANCE

● Mission of the automatic pilot is precision flight. Instantly, it detects and corrects the smallest deflection. It is a mechanical "nerve center" whose sensitivity to variations from a fixed course far excels that of the human brain.

"Anatomy" of the Automatic Pilot

1100 parts comprise the automatic pilot built by **JACK & HEINTZ, INC.**, for various types of military and commercial airplanes. Important elements of the automatic pilot are the rubber parts illustrated. Production of these vital parts to exacting standards is the responsibility of The Ohio Rubber Company. It takes a completely qualified organization to fulfill such responsibilities successfully. It may be summed up in one word . . .

"Orco-Operation"...

which includes complete research, engineering, and manufacturing facilities in the fields of mechanical molded and extruded rubber and synthetic rubber together with modern processes for bonding rubber and synthetic rubber to metals and other materials. May we direct this versatility to YOUR requirements?

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